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Mosquito News

Published Quarterly
by the
AMERICAN MOSQUITO CONTROL ASSOCIATION, INC.

VOLUME 14 SEPTEMBER, 1954 NUMBER 3

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MOSQUITO NEWS

Official Publication of the American Mosquito Control Association, Inc.

Editorial Office, State Education Building, Albany, N. Y.

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Published by

AMERICAN MOSQUITO CONTROL ASSOCIATION, INC.

Printed by

Boyd Printing Company, Inc., Albany, N. Y.

A quarterly journal published on the 20th of March, June, September and December. Devoted to the improvement and the sound extension of mosquito control and related work as a vital public health service.

SUBSCRIPTION RATES

$5.00 per Year (U. S. money), Single Copies, $1.75
Mailed without charge to members of the Association.

MEMBERSHIP DUES—$5.00

BUSINESS COMMUNICATIONS

Communications relating to editorial matters and manuscripts submitted for publication in Mosquito News should be addressed to Donald L. Collins, Editor, Mosquito News, New York State Museum, Albany, New York.

Communications relating to advertising space should be addressed to W. E. Bickley, Advertising Manager, Mosquito News, Univ. of Maryland, College Park, Md.

Communications relating to subscriptions to Mosquito News, Membership in the American Mosquito Control Association, and other association matters should be addressed to T. G. Raley, Executive Secretary, American Mosquito Control Association, 1941 Front St. W., Selma, Calif. Changes of address should reach the Secretary before the first of the month of publication.

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ARTICLES

CATCH BASIN SPRAYING

FRANKLIN C. WRAY

Technical Director, DesPlaines Valley Mosquito Abatement District, Lyons, Illinois

The DesPlaines Valley Mosquito Abatement District, Lyons, Illinois, is using two motorcycles to spray the 29,505 street catch basins within the District boundaries. The first motorcycle units were put into service in 1928. Similar units are now in use in many abatement districts throughout the United States.

The unit now in use consists of a Harley-Davidson servi-car with a 20-gallon larvicide tank inside the package compartment, capable of withstanding 200 pounds pressure per square inch. An automatic safety valve is installed in the tank to release pressure at 100 pounds per square inch. A two-cylinder air-cooled air compressor mounted on the frame and driven by a sprocket on the rear wheel provides pressure in the larvicide tank. To build up pressure to the necessary 90 pounds, the operator engages the compressor, making it unnecessary to depend on gasoline stations for air pressure.

The larvicide is ejected from the tank through a one-half inch neoprene hose to a hand spring shut-off valve. A one-eighth inch standard pipe 40 inches long is attached to the hose, terminating in a special nozzle welded to the pipe, which atomizes the larvicide and prevents dripping.

The operator sprays the catch basins as the nozzle is thrust down, so that any possible dripping will have ceased before removal of nozzle. Otherwise, there may be burning of grass or vegetation surrounding the catch basin.

The secret of the success of these units is in the nozzles, which are made in our shop. The District mechanic, George Leibundguth, has in the course of many years become an expert in their manufacture. The nozzle is drilled radially with six 1/32 inch holes, inclined downward at approximately a 30° angle, producing a radial spray, as shown in Fig. 1.

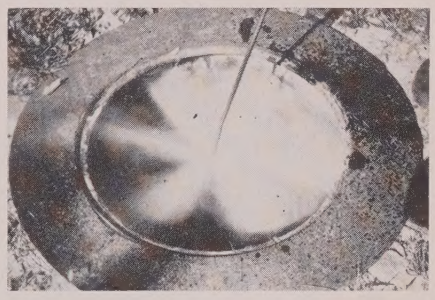

FIG. 1. A close-up view of the spray pattern, as used in spraying street catch basins.

This paints the catch basin walls with a residual deposit of insecticide. The excess runs down and covers the bottom of the basin.

The larvicide used for the last four years is 25 per cent technical DDT in E-407, a high solvent oil. This material is applied to all catch basins at a rate of one-half pint per basin. Spraying of catch basins is begun late in May and finished by the 10th of July when heavy breeding of *Culex pipiens* has just commenced. One spraying per season is effective.

Immediately after completion of spraying and again in mid-August close inspections are made to determine thoroughness of application and whether or not any breeding exists. Inspection of these catch basins in late August showed less than 2 per cent breeding, while in adjacent areas where the basins had not been sprayed 29 per cent of the basins were breeding in 1952 and 48 per cent in 1953.

The servi-car type of motorcycle is preferable to the old style side car, as they are easier to steer when loaded with oil and less liable to defects such as bending of the frame. The clutch occasionally has to be replaced due to the excessive number of starts and stops. Rough, unpaved roads are avoided as much as possible.

After completion of the catch basin spraying program, the motorcycles are used for inspection of home premises, wet lots and field inspection where it is not necessary to leave the road.

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THE MOSQUITO FISH *GAMBUSIA AFFINIS* (BAIRD AND GIRARD) IN ALBERTA

G. ALLEN MAIL

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Recently the writer observed a reference by Dr. Don M. Rees in COPEIA regarding the introduction into Utah of the top feeding minnow *Gambusia affinis*. Rees stated that to his knowledge these fish had never been successfully introduced so far north where the winters were as severe as they are in Utah. Rees at that time was unaware that the late Mr. Eric Hearle and the writer, during mosquito abatement studies for the Canadian Entomological Branch at Banff in 1924, had introduced this fish into Alberta. At that time approximately 200 fish were imported from California and held for some months in a cold woodland pool near the field laboratory. Here they remained vigorous and healthy but did not multiply. From this stock about 25 fish were planted in the warm waters overflowing from the Cave and Basin swimming pool at Banff. These waters flooded an extensive area of swampland below the swimming pool. The waters of this swamp (which was a prolific breeding place for mosquitoes) were foul and emitted a strong sulphur odor. In fact, *Culiseta inornata* larvae in this swamp were coated with a deposition of sulphur which gave them a most remarkable appearance but did not appear to inhibit their development.

Following the reading of Rees' article, the Superintendent of the Banff National Park was communicated with and inquiries made regarding the fate of the *G. affinis* planted in Banff waters in 1924. A reply was received stating that these swamps had been checked by the Park Warden Service as recently as the summer of 1953 and the presence of numerous schools of these minnows at that time was confirmed. This extends the northern limit for the successful establishment of *G. affinis* by several hundreds of miles. Incidentally, the presence of these minnows in Banff waters has puzzled many visiting zoologists.

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FLIGHT MUSCLE AUTOLYSIS IN *AEDES COMMUNIS* (DEGEER)

B. HOCKING

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Since a preliminary report of the autolysis of the flight muscles in *Aedes communis* was made (Hocking, 1952), Johnson (1953) has reported a similar phenomenon in seven species of aphids. The same phenomenon may explain in part the observations of Jackson (1952) on water beetles. In view of its bearing on blood sucking habits, a full investigation of this phenomenon in mosquitoes and other groups of blood-sucking insects would be worthwhile.

Ever since the inception of serious studies of the *Aedes* mosquito problem in northern Canada in 1946, the source of blood meals for these vast numbers of insects has been a perplexing problem. This problem prompted studies using the precipitin test which have been described by West (1951). To the question: "Where does *A. communis* get its blood meals?" we can now answer, as an indirect result of these precipitin test studies, it doesn't.

In 1951 one of Dr. West's assistants collected large numbers of mosquitoes at Churchill, Manitoba in the search for blood engorged females. He described finding amongst his collections specimens which appeared as though the abdomen were covered with scales like those of a fish. These proved to be gravid females, the scale-like appearance resulting from eggs showing through the wall of the abdomen. When they were preserved in alcohol a glance was sufficient to show that there was something strange about the thorax, which had a translucent appearance. This was particularly noticeable in the region of the postpronotum (fig. 1). Dissection showed at once that in specimens in which the eggs were fully developed, the flight muscles had completely disappeared, leaving a virtually empty thorax, although the ovaries themselves sometimes obtruded into this at the posterior end (fig. 3).

Observations on this interesting phenomenon were continued in 1952, and in 1953 L. A. Burgess of the Division of Entomology, Canada Dept. of Agriculture kindly collected some further material of gravid females for me. The information now available is summarized in Table I; because of the different temperature conditions in different seasons, dates of the break-up of river ice are given to permit comparison. This shows that the process requires about 18 days at the temperature prevailing at Churchill at this time of year; that is, about 450 degree-days above 32° F. As a result of the examination of further material, the average number of eggs developed can be revised to 65 and the maximum number to 93. There is still no evidence of blood feeding in this form of *A. communis,* nor have morphological characters been found to separate it, in any stage, from the more widespread blood feeding form. The average value of the proboscis length/wing length ratio for

TABLE 1—The dates of emergence and of egg development in *Aedes communis* at Churchill, Manitoba. 1951–53.

	1948	1951	1952	1953
Churchill River ice broke up	14 June	11 June	3 June	19 June
Days after ice break up to:—				
Peak emergence	9–28	..	..	21–24
First gravid ♀ found	..	28	31	..
Gravid ♀♀ most abundant	..	33	35	31–35
Last gravid ♀ found	..	49	41	..

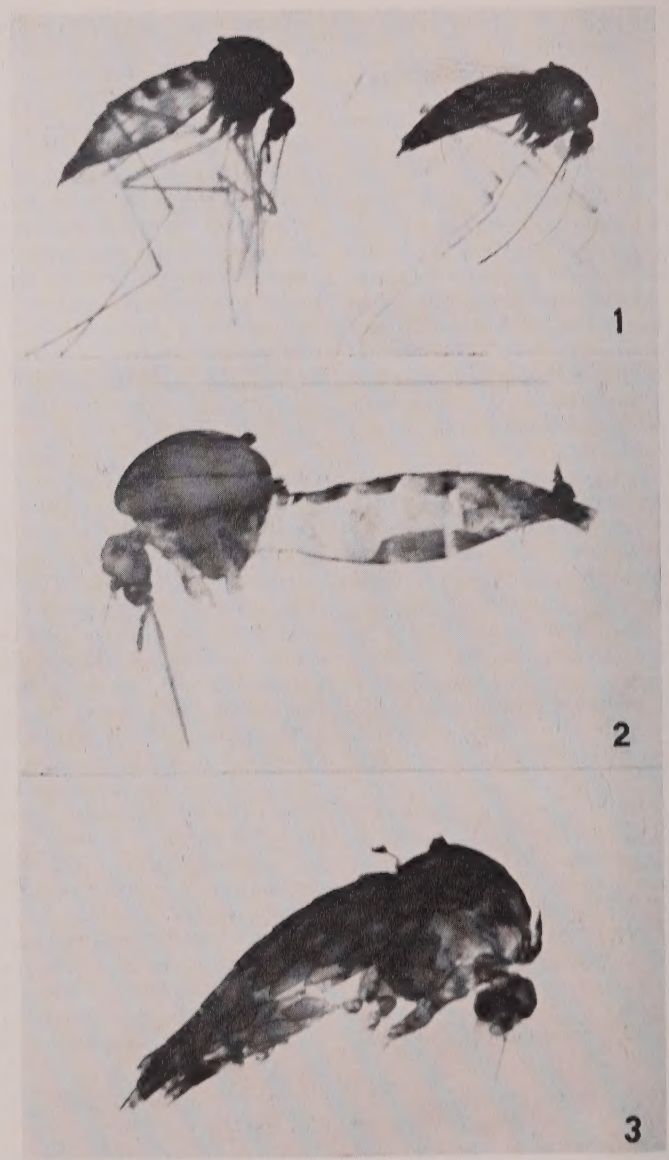

FIG. 1. On the left a newly emerged specimen of *A. communis* showing the transparent abdomen and the opaque thorax. On the right a gravid specimen, the eggs visible in the abdomen and the thorax translucent. Note the clear spot by the postpronotum.

FIG. 2. Sagittal section of newly emerged specimen of *A. communis*. Flight muscles well developed.

FIG. 3. Sagittal section of gravid specimen showing eggs obtruding into the thorax. No flight muscles.

these specimens was 0.738 ± 0.029. This suggests that only the small form (Hocking *et al.*, 1950) has this habit.

Nitrogen estimations were done on the flight muscles of newly emerged females and on mature eggs, to determine how many eggs these muscles are equivalent to, in terms of nitrogen. The structures were dissected out, dried at 100° C., and the nitrogen estimated by the Kirk-Kjeldahl method (Kirk, 1936); about 2 mg. dry weight of muscle or 100 eggs were used in each sample. The average dry weight of 100 eggs was 0.87 mg. The average percentage of nitrogen on dry muscle weight was 11.6 and on dry egg weight 8.2, or 0.000713 mg. per egg. The average weight of the fresh indirect flight muscles in *A. communis* is 0.430 mg. (Hocking, 1953); if the water content is assumed to be 75 per cent, this means that the flight muscles can provide the nitrogen required in the development of 18 eggs, nearly a third of the average number developed. This is a significant contribution, although not so great as was at first supposed.

Gravid specimens of several other species were collected during the search for this species. These were all examined for signs of flight muscle autolysis. No sign of this was found in *A. nigripes* Zett., *A. nearcticus* Dyar, *A. campestris* D. & K., *A. cinereus* Meig., or *A. hexodontus* Dyar, all of which are established blood feeders. Specimens of the non-biting chaoborine species *Mochlonyx culiciformis* DeG., collected on July 10 and 13, 1952, however, showed some breakdown. This was less complete than that found in *A. communis*, but in neither specimen were the eggs fully mature.

Summary: The previously reported autolysis of the flight muscles concurrently with egg production in *Aedes communis* (DeG.) is described in more detail. The process occupies about 18 days. Up to 93 eggs are developed, the average number being 65. The nitrogen content of the flight muscles and of the eggs was estimated. The indirect flight muscles contain enough nitrogen to provide this for the development of 18 eggs. A similar autolysis of the flight muscles concurrently with egg development is reported in the non-biting mosquito *Mochlonyx culiciformis* DeG. Gravid females of five biting species of *Aedes* were collected and examined; none of these showed signs of autolysis.

Acknowledgment: Some of these observations were made while in the employ of the Medical and Veterinary Entomology Unit, Division of Entomology, Canada Department of Agriculture.

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THE LACK OF AUTOLYSIS OF THE FLIGHT MUSCLES OF *AEDES COMMUNIS* (DE GEER) (CULICIDAE) IN THE LABORATORY

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Many authors have commented on the mystery of the nitrogen source for egg development in the very plentiful northern species of mosquitoes. Surveys of possible blood sources in comparison to the hordes of blood-sucking female mosquitoes have led to the idea that mosquitoes in the north must be capable of developing eggs without blood meals. In my laboratory at Ft. Churchill, Manitoba, Canada, repeated efforts have been made to obtain eggs from blood-sucking females denied a protein food source but maintained on sugar solutions or raisins alone; no instance of egg development or oviposition has occurred.

Hocking, in 1952 reported the progressive autolysis of the flight muscles of a series of field collected specimens of a mosquito believed to be *Aedes communis* (De Geer) from the Ft. Churchill, Manitoba region. The autolysis proceeded as the eggs formed in the ovaries. He postulated the autolysis of these muscles to provide a source of protein for the development of the eggs.

In 1949 (unpublished) I discovered that *Aedes communis* from the Ft. Churchill region was capable of developing and ovipositing viable eggs with a food source of sucrose or raisins alone. Furthermore, no efforts would induce this species to take a blood meal in the laboratory nor were any observations made of positively identified *Aedes communis* females taking blood meals in the field. The specimens Hocking observed were collected, as would be expected with this non-attracted species, in sweeps made in the grasses around pools known to breed numbers of *Aedes communis* larvae. The specimens were tentatively identified as *Aedes communis* and there is no reason to believe that they were other than this species.

The reported autolysis was of interest to me, particularly since it appeared to give evidence of a possible egg development without blood in northern mosquitoes, and also because progressive autolysis would afford an admirable opportunity for study of flight characteristics as the muscles disappeared. Therefore in the laboratory, a number of *Aedes communis* females were permitted to emerge from field collected pupae, were fed on sucrose alone, and each day a sample was removed and the living insects were killed and fixed immediately in Carnoy's fixative. The last sample was observed to have fully developed eggs in the ovaries; and eggs were being laid in the cages. But some of the gravid females were noted to be capable of flight. The samples were examined for muscle autolysis by sectioning and by gross dissection. No sign of reduction or histological abnormality in the flight muscles was noted, even in the specimens with fully developed eggs. Comparisons were made with the *Aedes communis* newly emerged and with *Aedes hexodontus* Dyar. Figure 1 presents a photograph of an *Aedes communis* female with eggs fully developed and shows a full complement of flight muscles.

Dr. Hocking, by personal communication (1954), has suggested that perhaps the non-autolysing specimens were a different form of *Aedes communis* from those that he observed. In 1950 he showed two peaks in the graph of proboscis to wing length ratio of adult females of *Aedes communis* in the Churchill region and this suggested the presence of two forms. Dr. Hocking has informed me that the proboscis to wing length ratio of the specimens in which he observed autolysis was $.738 \pm .029$. The same ratio for 25 of the specimens showing no auto-

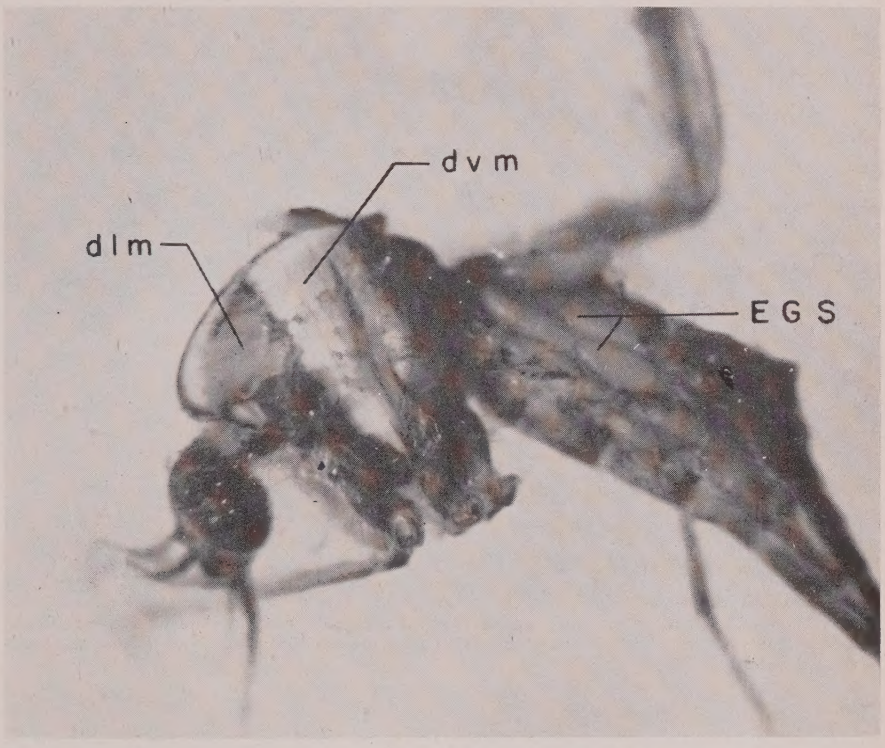

FIG. 1. A whole mount of an *Aedes communis* female dissected to show the fully developed eggs (EGS) and the flight muscles, the dorso-ventrals (dvm) and the dorso-longitudinals (dlm).

lysis in my laboratory was .721 ± .027. This mean falls well within the same peak as that of Dr. Hocking's and not near the peak of the postulated other form of *Aedes communis* which has its mean at approximately .85.

It appears that autolysis of the flight muscles is not the answer to the development of the eggs in *Aedes communis* in the laboratory. We are left with the "fat body" and the autolysis of other muscles as possible protein sources. Roubaud (1932) has reported the presence of larval muscles in recently emerged *Culex* adults and I have observed similar muscles in *Aedes communis*. These muscles disappear rapidly after emergence; and egg development is noted as the disappearance takes place. Circumstantially one might expect, as suggested by Roubaud, that the histolysis of these muscles contributed some protein for use in egg development. It may actually trigger development. I have sectioned recently emerged *Aedes hexodontus* adults and have observed similar larval muscles. Rapid disappearance is also the case in this species, but the histolysis does not contribute to egg development because no egg development is observed in adults which have not had a blood meal.

Both *Aedes communis* and *Aedes hexodontus* have extensive "fat body" on emergence and whereas *Aedes communis* may use the stored protein from this source for egg development it does not seem to be available to *Aedes hexodontus* without benefit of at least a blood meal.

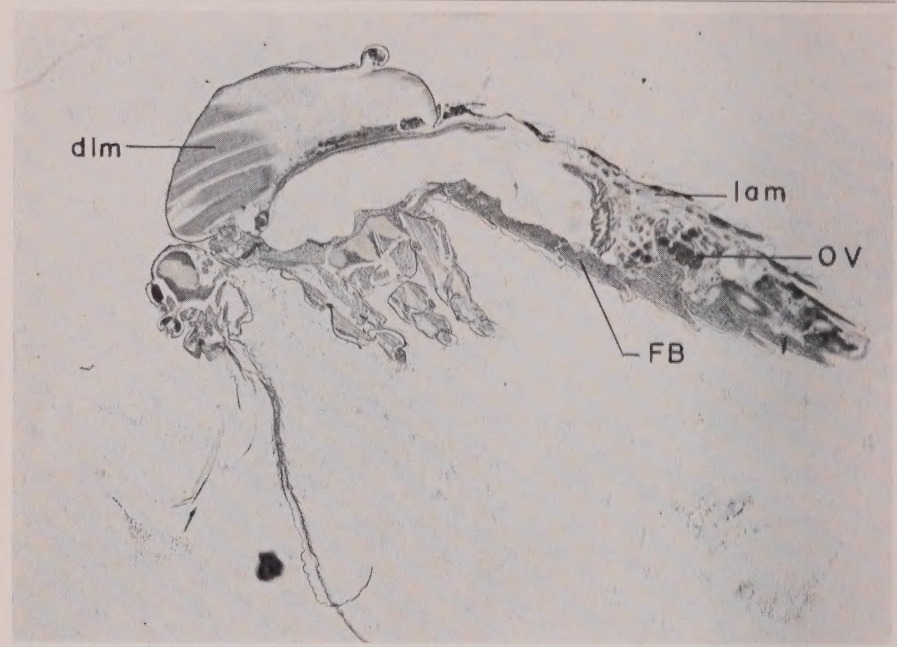

FIG. 2. A sagittal section of an *Aedes communis* female, recently emerged, showing the dorso-longitudinal flight muscles (dlm), the larval muscles (lam), the extensive fat body (FB) and the undeveloped ovaries (OV).

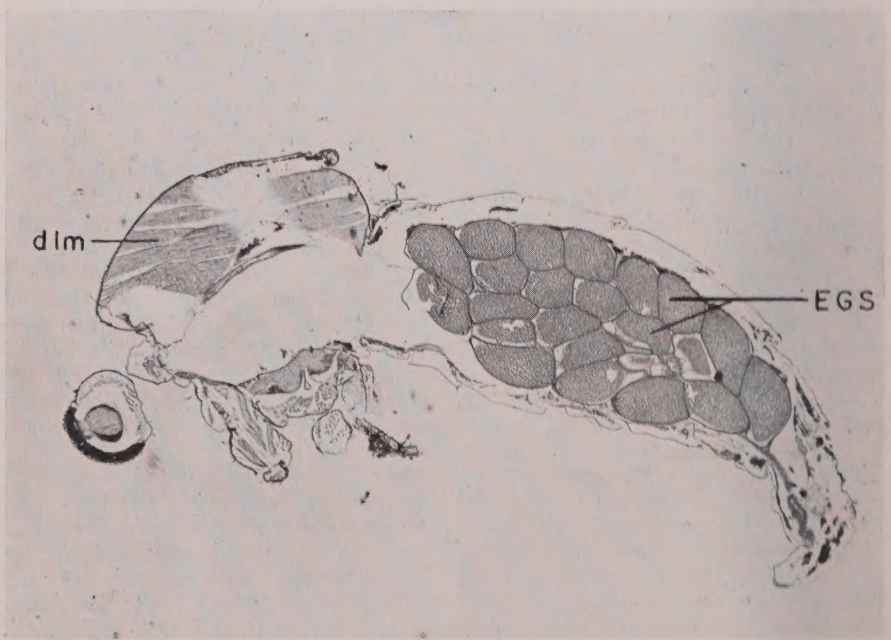

FIG. 3. A sagittal section of an *Aedes communis* female, with eggs (EGS) almost completely developed, with larval muscles absent, with a much reduced fat body but with the dorso-longitudinal flight muscles (dlm) intact.

Certainly the physiology of egg production in the two species appears to be quite different. Figure 2 shows a specimen of *Aedes communis,* recently emerged, with dorsal longitudinal flight muscles, larval muscles and extensive "fat body." Figure 3 shows another specimen of *Aedes communis* with eggs almost completely developed. The dorsal longitudinal flight muscles are present. Of particular interest is the reduction of the "fat body" and the absence of larval muscles which have long since histolysed. The "fat body" of *Aedes hexodontus* also becomes reduced with age; however no egg production takes place without blood. In the blood-sucking species we must still continue to consider blood meals as the most probable source of protein for egg development.

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SIMPLE LARVAL AND ADULT MOSQUITO INDEXES FOR ROUTINE MOSQUITO CONTROL OPERATIONS

JOHN N. BELKIN

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Few of the numerous methods used at present to obtain an index of larval or adult mosquito populations in routine mosquito control operations are satisfactory or reliable. While engaged in entomological phases of mosquito control operations in the Solomon Islands in 1943–1945 I used a simple index which appeared to be quite reliable and required a minimum of work for the field personnel. Recently this method has been tried on a limited scale in California with satisfactory results. Therefore it seems advisable to bring it to the attention of persons engaged in mosquito control operations.

It is a well known fact that mosquito populations, both adult and immature stages, are not dispersed at random but occur in concentrations over a wide and variable area. The difficulty with most methods of estimating mosquito populations, such as the popular "average per dip" index for larval populations and the "mosquitoes per hour" or per man-hour for adult populations, is that only one of these variables is taken into account. In developing our simple index we therefore attempted to include both factors of density and extent or spread of the population. Essentially the method consists of standardizing the unit areas to be sampled, measuring the density for each unit area and combining this information into an index. No originality is claimed for this idea but it appears that it has not been widely applied to developing an index suitable for mosquito control operations.

Breeding Index (BI). The breeding index as developed by us is particularly adapted to anopheline breeding in situations where the larval breeding places consist of small, temporary pools as well as streams and other permanent bodies of water, and where there is a considerable fluctuation in the number and extent of breeding sites. With slight modifications

it can be adapted to culicine breeding as well as to different types of breeding sites.

The information necessary to determine the breeding index is obtained by field checkers using the standard dipping technique. To minimize individual variations in dipping, each man is assigned to an area for an entire season. The field checkers are trained to estimate water surface areas. A specific number of dips is taken per unit surface. In our case we took 20 dips for every 100 square feet of effective breeding surface, disregarding open, deep, standing water or open, flowing water which by experience we knew did not serve as breeding sites. The field checkers are provided with a standard form on which separate entries are made for every situation checked. Such a situation consists of a single body of water or a series of pools, puddles, etc., in a restricted area which is conveniently checked as a unit. For each situation a brief identification and description is made, followed by entries for the total number of dips taken, the number of positive dips (containing larvae or pupae or both) and the total number of larvae and pupae dipped. A representative sample of mosquitoes is also taken for every situation for laboratory identification. In checking, no record is made of negative dips until the first positive dip is obtained, then a record is kept of positive dips as well as of all dips taken. After the first positive dip, the full number of dips required by the size of the area checked is taken. For situations where no positive dips are obtained no entries are made other than a record that they were checked.

In the headquarters laboratory the larvae and pupae in each sample are identified to species as needed or desired. For each situation the number of breeding places and the average per dip are determined and from them the breeding index is compiled. The breeding index can be determined, if desired, for each subdivision of the area under control, for each species and for each week with very little additional work.

A sample report on the anopheline breeding in the Lunga District of Guadalcanal for the month of April, 1945 is illustrated here (fig. 1). The actual method of determining the breeding index can be best understood by inspection of this form and the explanation of abbreviations which follow:

BP: Breeding Place. A "breeding place" is defined, for the purpose of obtaining the breeding index, as any situation in which from 1 to 20 positive dips are obtained. If no positive dips are obtained the situation is disregarded. If in any given situation (a single body of water or a series of pools, puddles, etc. in a restricted area) more than 20 positive dips are obtained, then the number of breeding places recorded is one for each 20 positive dips or fraction thereof. If a more refined index is desired fractional breeding places may be determined as follows: $BP = \frac{\text{total positive dips}}{20}$.

TLP: Total Number of Larvae and Pupae. The total number of larvae and pupae found in any given situation is recorded, regardless of the number of breeding places.

ND: Number of Dips. The number of dips taken in any given situation is standardized to correspond to the surface area of the water present—say 20 dips per 100 sq. ft. of water surface. In dipping no record is kept of negative dips until the first positive dip is obtained, following which all dips taken are recorded. For example, in a series of small pools with a surface area of approximately 200 sq. ft., roughly 40 dips are taken without a single larva. This situation is disregarded as a breeding place and no record is kept. In another situation with approximately the same water surface, after 5 negative dips a positive dip is obtained. The first 5 dips are disregarded, and the full 40 dips are taken for this situation and the number of positive dips recorded to determine the number of "breeding places."

APD: Average per Dip. The average number of larvae and pupae per dip is determined by dividing the total number

MALARIA CONTROL - LUNGA DISTRICT

- Anopheline breeding for the month of April 1945 -

SPECIES	A	31 Mar - 6 Apr BP	TLP	ND	APD	BI	7 Apr - 13 Apr BP	TLP	ND	APD	BI	14 Apr - 20 Apr BP	TLP	ND	APD	BI	21 Apr - 27 Apr BP	TLP	ND	APD	BI	Entire Period BP	TLP	ND	APD	BI
	I																									
ANOPHELES	II	7	48	135	0.36	2.52	3	22	60	0.37	1.11	2	32	40	0.80	1.60	1	9	20	0.45	0.45	13	111	255	0.44	5.72
FARAUTI	III	*31	698	620	1.13	35.03	*24	337	480	0.70	16.80	*2	34	40	0.85	1.70	15	140	300	0.47	7.05	*72	1209	1440	0.84	60.48
LAVEPAN	IV	9	126	180	0.70	6.30	10	56	118	0.47	4.70	*6	33	65	0.51	3.06	*4	15	28	0.54	2.16	*29	230	391	0.59	17.11
	E	*47	872	935	0.93	43.71	*37	415	658	0.63	23.31	*10	99	145	0.68	6.80	*20	164	348	0.47	9.40	*114	1550	2088	0.74	84.36
	I																									
ANOPHELES	II											1	9	20	0.45	0.45						1	9	20	0.45	0.45
PUNCTULATUS	III																									
DONITZ	IV																									
	E											1	9	20	0.45	0.45						1	9	20	0.45	0.45
	I																									
ANOPHELES	II																									
SOLOMONIS	III											*1	12	20	0.60	0.60						*1	12	20	0.60	0.60
B. K. & B.	IV																									
	E											*1	12	20	0.60	0.60						*1	12	20	0.60	0.60
	I																									
ANOPHELES	II																									
LUNGAE	III	*4	30	80	0.38	1.52	*9	26	180	0.14	1.26	*3	20	60	0.33	1.00						*16	76	320	0.24	3.84
B. & S.	IV						1	1	10	0.10	0.10	*1	3	5	0.60	0.60	*1	2	6	0.33	0.33	*3	6	21	0.29	0.87
	E	*4	30	80	0.38	1.52	*10	27	190	0.14	1.40	*4	23	65	0.35	1.40	*1	2	6	0.33	0.33	*19	82	341	0.24	4.56
	I																									
TOTAL	II	7	48	135	0.36	2.52	3	22	60	0.37	1.11	3	41	60	0.68	2.04	1	9	20	0.45	0.45	14	120	275	0.44	6.16
ANOPHELES	III	31	728	620	1.17	36.27	24	363	480	0.76	18.24	4	66	80	0.83	3.32	15	140	300	0.47	7.05	74	1297	1480	0.88	65.12
	IV	9	126	180	0.70	6.30	11	57	128	0.45	4.95	6	36	65	0.55	3.30	4	17	28	0.61	2.44	30	236	401	0.59	17.70
	E	47	902	935	0.96	45.12	38	442	668	0.66	25.08	13	143	205	0.70	9.10	20	166	348	0.48	9.60	118	1653	2156	0.77	90.86
	I																									
BIBONELLA	II	2	3	20	0.15	0.30											1	8	20	0.40	0.40	3	11	40	0.28	0.84
HOLLANDI	III	1	13	20	0.65	0.65						2	19	40	0.48	0.96	1	12	20	0.60	0.60	4	44	80	0.55	2.20
TAYLOR	IV																									
	E	3	16	40	0.40	1.20						2	19	40	0.48	0.96	2	20	40	0.50	1.00	7	55	120	0.46	3.22

BREEDING INDEX SUMMARY

		Weeks 1	2	3	4	All
A	I. Lunga Delta					
R	II. Lunga to Matanikau	2.52	1.11	2.04	0.45	6.16
E	III. Matanikau to Bonegi	36.27	18.24	3.32	7.05	65.12
A	IV. Bonegi to Umasani	6.30	4.95	3.30	2.44	17.70
S	E. Entire District	45.12	25.08	9.10	9.60	90.86

LEGEND

*One or more breeding places repeated under another species

A - Areas
APD - Average number of larvae and pupae per dip, TLP:ND
BI - Breeding index, APD x BP
BP - Number of breeding places, Based on 20 or less positive dips
ND - Total number of dips
TLP - Total number of larvae and pupae

of larvae and pupae (TLP) found in a situation by the total number of dips (ND) taken. In the above example, let us say 400 larvae and pupae were taken. Therefore, the average per dip would be $\frac{400}{40} = 10.00$.

BI: Breeding Index. The breeding index for any given situation or area is obtained by multiplying the number of breeding places (BP) by the average per dip (APD). In the above situation, let us assume that out of the 40 dips taken 25 were positive. This gives us 2 breeding places (BP). The average per dip (APD) for the entire situation was 10.00. (Note that it is not determined separately for each "breeding place.") The *breeding index* would therefore be $2 \times 10.00 = 20.00$.

This breeding index was used for 10 months on Guadalcanal in routine malaria control activities and proved to be a much more accurate, sensitive and time-saving method of comparing populations of immature mosquitoes than the conventional average per dip, which takes into account only the density of the population but not its extent.

It will be noted that, while there is practically no correlation between the average per dip (APD) and the breeding index (BI) as obtained by our method, there is more agreement of the latter with the total number of larvae and pupae (TLP). Therefore it would appear that the total number of larvae and pupae taken can be used directly for comparison of populations for a given area for different checking periods. It could easily be developed into an index but from our records it does not seem to be as reliable as our breeding index. On the other hand it is certainly a much more valuable figure than the average per dip index and could be used in routine mosquito control operations if an effort is made to standardize the unit area sampled and the number of dips taken in each unit. This would probably mean more reliance on the field personnel and more work for them.

Using the same principles a very simple breeding index may be determined for survey work or for checking purposes when the personnel and the time available are more limited. Every breeding site (body or container of water) may be considered separately and any convenient number of dips taken. The more dips taken the more reliable the index, but a fairly accurate comparative index may be obtained, even if only a few dips are taken, as long as the dips are made in several parts of the body of water checked. The same procedure is followed in the field as above but the following information is recorded by the checker for every breeding site:

SA—surface area of body of water serving as effective breeding site; in square feet.

ND—total number of dips taken, disregarding all negative dips prior to the first positive dip.

PD—positive dips obtained.

TLP—total number of larvae and pupae.

The breeding index for every site is then computed as follows:

$$BI = \frac{SA \times PD \times TLP}{ND \times ND \times 10 \text{ (or } 100)}$$

If the average per dip (APD) is computed separately then the breeding index is obtained as follows:

$$BI = \frac{SA \times PD \times APD}{ND \times 10 \text{ (or } 100)}$$

In either case the choice of the factor 10 or 100 in the denominator depends on the intensity of breeding. It is included merely to produce an index figure that can be easily handled. Of course once the choice is made, the same figure must be used throughout the area and the season.

The breeding index for an area is then obtained by summation of the indexes for all the individual breeding sites within the area.

It is obvious that many factors affect the breeding index and that it has many limitations. It appears nevertheless that it is much more reliable than any of the other methods now in general use. Undoubtedly

many refinements can be made to increase its reliability, but as it stands at present it requires less work on the part of the field personnel than the average per dip index, for it eliminates recording a great number of unnecessary negative dips.

Adult Index. We did not use a similar index to adult populations on Guadalcanal because of difficulties of sampling, but the same principles may be extended to obtain an adult index utilizing records from diurnal shelters, biting stations, or light traps. The number of mosquitoes collected per unit (hour or man-hour) in each station would correspond to the average per dip in the breeding index and every positive station would correspond to a breeding place. The adult index would be obtained by multiplying the over-all average of mosquitoes per unit in a given area by the total positive stations in that area. No doubt such an index could be refined by standardizing the stations or arbitrarily defining a unit station by some means such as the number of positive minute periods.

FIELD OBSERVATIONS ON LARVAL GROWTH RATES OF IRRIGATED-PASTURE MOSQUITOES IN WESTERN NEBRASKA (DIPTERA, CULICIDAE)

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Introduction. In western Nebraska, four species of mosquitoes, *Aedes dorsalis* (Meigen), *Aedes vexans* (Meigen), *Aedes nigromaculis* (Ludlow), and *Culex tarsalis* Coquillett, are commonly found in surface pools on irrigated salt grass pastures and hay meadows in the bottom lands along the North Platte River. In order to understand more clearly the relationship between irrigation and mosquito production, studies were initiated during the 1952 season on the biology of the immature stages of these four species. These studies were primarily concerned with the effects of temperature and population densities on growth rates. In addition, observations were made on the succession of mosquito species in the various habitats. The investigations were carried out under actual field conditions, and in practically every habitat studied a mixture of species was encountered; however, *A. dorsalis* was by far the most common.

A review of the literature indicates that very little has been published on the biology of these species in the Midwest. The major contributions concerning the four species in other areas are as follows: Rees and Nielsen (1947) published an account on the biology of *Aedes dorsalis* in Utah; Gjullin, *et al.* (1950) on *A. vexans* in the Pacific Northwest; Thurman, *et al.* (1951) and Husbands and Rosay (1952) on *A. nigromaculis* in California; Brookman (1950) and Jenkins (1950) on *Culex tarsalis*.

Methods. Several temporary pool sites in the vicinity of Mitchell, Nebr., were selected for study. These depressions were located in rough pasture areas where the vegetation consisted mainly of salt grass (*Distichilis* sp.) with other native grasses. During the first part of the season, the depressions were filled with water from rainfall or irrigation. Beginning in July, the sites were flooded by means of a gasoline-engine-driven pump. The controlled flooding permitted more accurate determination of the time required for completion of the larval and pupal stages.

Data were obtained from 14 temporary pool sites that were flooded one or more times during the season. Twenty-one floodings were studied: 17 at 24-hour intervals and 4 at 6-hour intervals. The surface areas of the pools ranged from 80 to 500 square feet and the maximum depth of water never exceeded more than about 1 foot.

Samples of the immature stages were collected by random dipping over the entire area of the pools, using a pint-size, white-enamel dipper. Daily population densities were determined by the average number of larvae per dip. The aquatic stages were strained out by pouring the water from each dip through a fine-mesh tea strainer. They were then transferred to alcohol vials by means of a small camel's-hair brush. All samples were examined in the laboratory where the numbers in each stadium were determined, and all fourth-instar larvae and pupae were identified to species. The first, second, and third instars were identified only to genus.

RESULTS. During the course of this study, 81,255 fourth-instar larvae were identified. *Aedes dorsalis* was the most common species, accounting for 81 per cent of the total. *A. vexans* made up 6 per cent, *A. nigromaculis*, 7 per cent, and *C. tarsalis*, 6 per cent.

A summary of the number of days required for the *Aedes* species to reach fourth-instar and pupal stage is shown in table 1. At average air temperatures between 68.2° F. and 76.9° F., *A. dorsalis*

TABLE 1.—Time required for *Aedes dorsalis*, *A. vexans*, and *A. nigromaculis* to reach the fourth-instar and pupal stage, May 16 through September 18, 1952, Scotts Bluff County, Nebraska

Pool number	Date flooded	Avg. air temperature ° F.*	No. of days required to reach IV-instar			No. of days required to reach pupal stage		
			Aedes dorsalis	*Aedes vexans*	*Aedes nigromaculis*	*Aedes dorsalis*	*Aedes vexans*	*Aedes nigromaculis*
1–1 **	May 16 ***	53.7	8	8	9	12		12
2	June 12	73.5	5	5	4	7		6
3	June 21	69.1	4	4	5	8	7	
4	June 21	68.2	4	5	4	8	7	7
1–2	June 24	70.5	5	6	5	7		7
5–1	June 24	70.5	5	5	5	7	7	6
5–2	July 22	76.9	4	3	3	5	5	5
7–1	July 22	76.9	4	3	3	5	5	5
5–3	Aug. 1	73.2	4	3		6	5	
8	Aug. 1	73.2	4	3	3	6	5	5
9–1	Aug. 4	70.0	4	3	3	6	6	5
7–2 ****	Aug. 6	68.9	3¾	3	4¼	6¾	5¾	6
10	Aug. 7	69.4	4	4	4	7	7	6
9–2	Aug. 12	69.6	3	4	3			5
11	Aug. 18	73.6	4		3	6		5
9–3 ****	Aug. 19	73.1	3¼	3¼	3	5	4½	4
13 ****	Aug. 19	73.4	3¼			7		
5–4 ****	Aug. 21	72.2	3¼	3	4¼	5	4¾	4¾
14	Aug. 21	72.8	6	6	5		7	6
9–4	Sept. 15	58.8	7	8	8	12	12	11
5–5	Sept. 18	60.2	7	7	8	11	9	9

* From daily maximum-minimum air temperatures recorded 5 miles east of Mitchell.
** Substation numbers indicate number of times pool was flooded.
*** Approximate date flooded.
**** 6-hour check.

required 3¼ to 6 days to develop to the fourth-instar and 5 to 8 days to the pupal stage; *A. vexans,* 3 to 6 days to the fourth-instar and 4½ to 7 to the pupal stage; and *A. nigromaculis,* 3 to 5 days to the fourth-instar and 4 to 7 to the pupal stage. At average air temperatures between 53.7° F. and 60.2° F., 7 to 8 days were required for *A. dorsalis* and *A. vexans* to reach the fourth-instar and 9 to 12 days to reach the pupal stage. *A. nigromaculis* required 8 to 9 days to reach the fourth-instar and 9 to 12 days to attain the pupal stage at the same temperatures. A comparison of the larval growth rates of *A. dorsalis, A. vexans,* and *A. nigromaculis* for various periods and different temperatures during the season is presented in figure 1.

The growth rates of *Aedes* larvae in two pools (No. 5–3 and 7–1) supporting widely differing larval population levels are shown in figure 2. Growth-rate patterns of the early instars were similar in both pools even though the daily population density was considerably higher in pool No. 7–1. In the pool with the higher larval density a greater percentage of the larvae spent more time in the fourth instar.

Collection of larval samples at 6 a.m.,

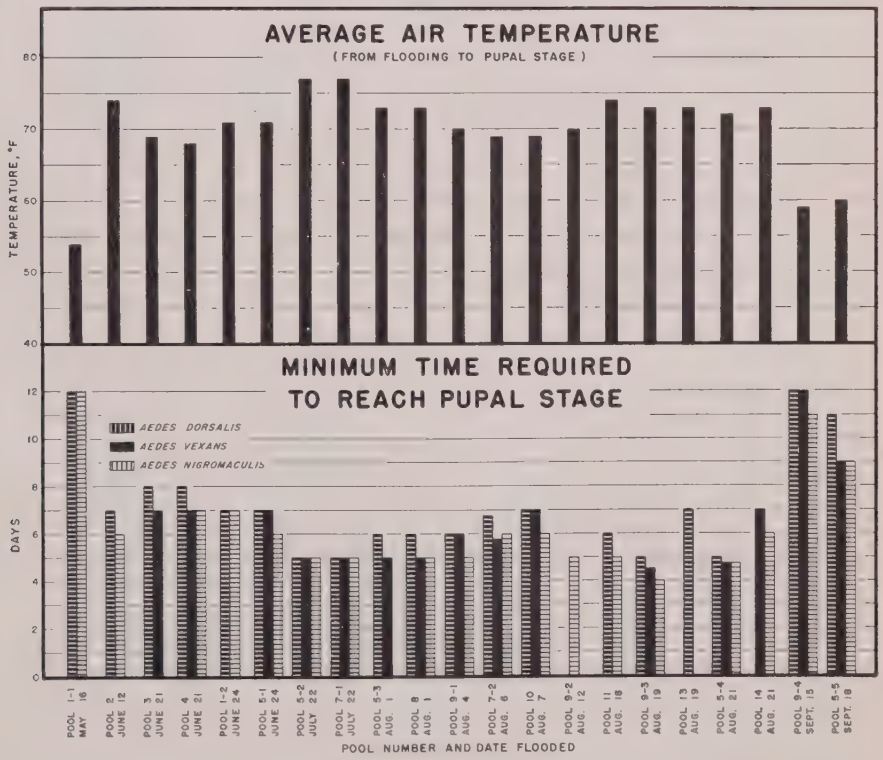
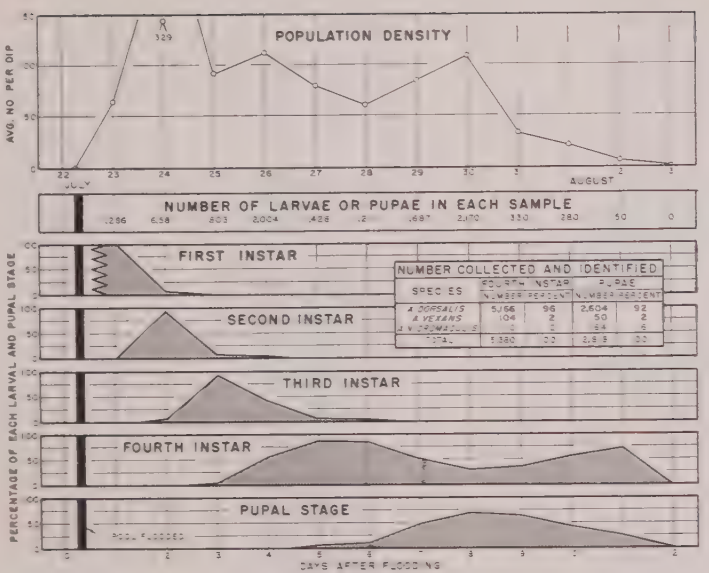
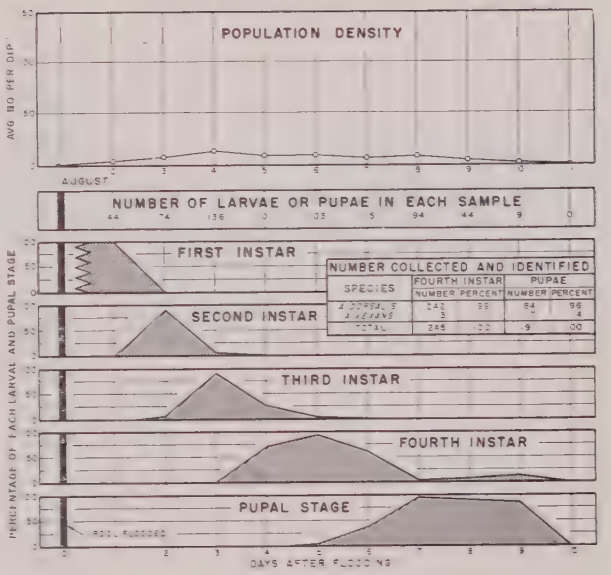


Figure 1. Relationship between average air temperatue and minimum number of days required for *Aedes dorsalis*, *A.vexans*, and *A.nigromaculis* to reach the pupal stage in surface pools flooded at irregular intervals. May – September, 1952. Scotts Bluff County, Nebraska.



POOL NO. 7-1



POOL NO. 5-3

Figure 2. The rates of development of *Aedes* larvae and pupae in surface pools with high and low population densities. Near Morrill, Nebraska, July-August, 1952.

12 m., 6 p.m., and 12 p.m. permitted a more accurate determination of the time required for completion of each stage. The growth-rate patterns of *Aedes* larval instars and pupae for one pool inspected at 6-hour intervals are shown in figure 3. This pool was flooded from 10:30 to 11:00 a.m. on August 21, and hatching had occurred by 1 p.m. Nearly all the larvae changed to second instars between 6 p.m. and 12 p.m. on August 22. The time spent in the second stadium was shorter than that in the others. Fourth-instar larvae of *A. dorsalis* were first collected at 6 p.m. on August 24 and the first pupae at 12 m. on August 26. The minimum time observed for completion of the larval stage of *A. dorsalis* was 5 days. Adult emergence occurred on August 27 and 28, as indicated by the low percentage of pupae. By August 29 most of the fourth-instar larvae had changed to pupae.

In three of the pools studied at 6-hour intervals, a difference was noted in the rates of development of *A. dorsalis*, *A. nigromaculis*, and *A. vexans* (only *A. dor-*

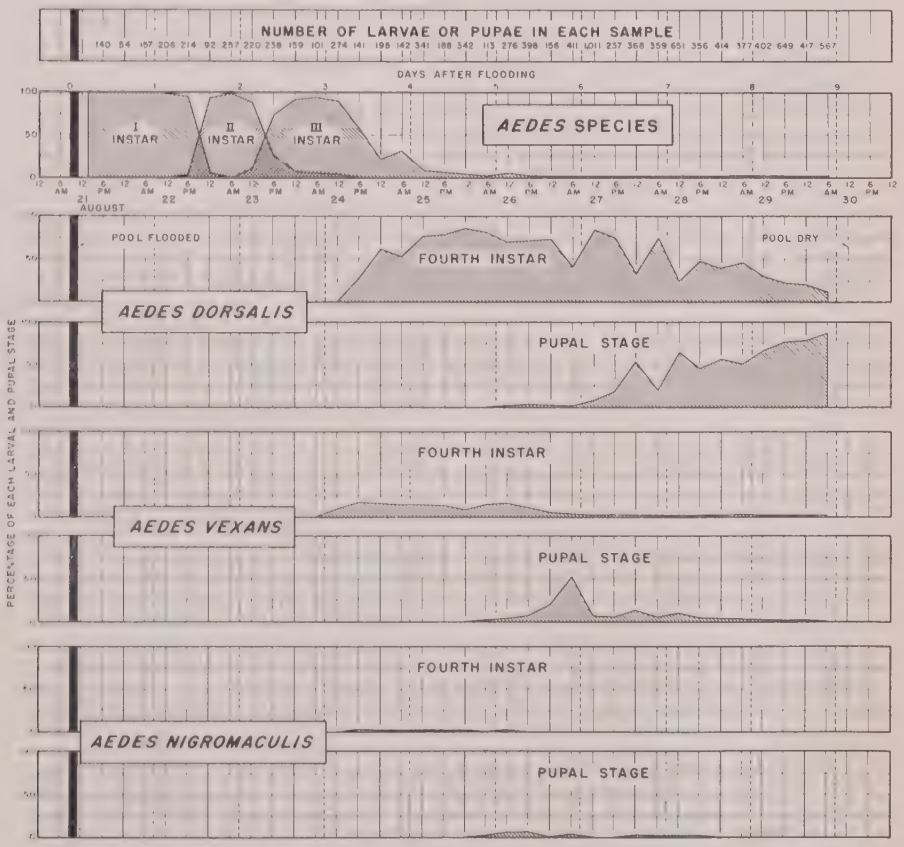
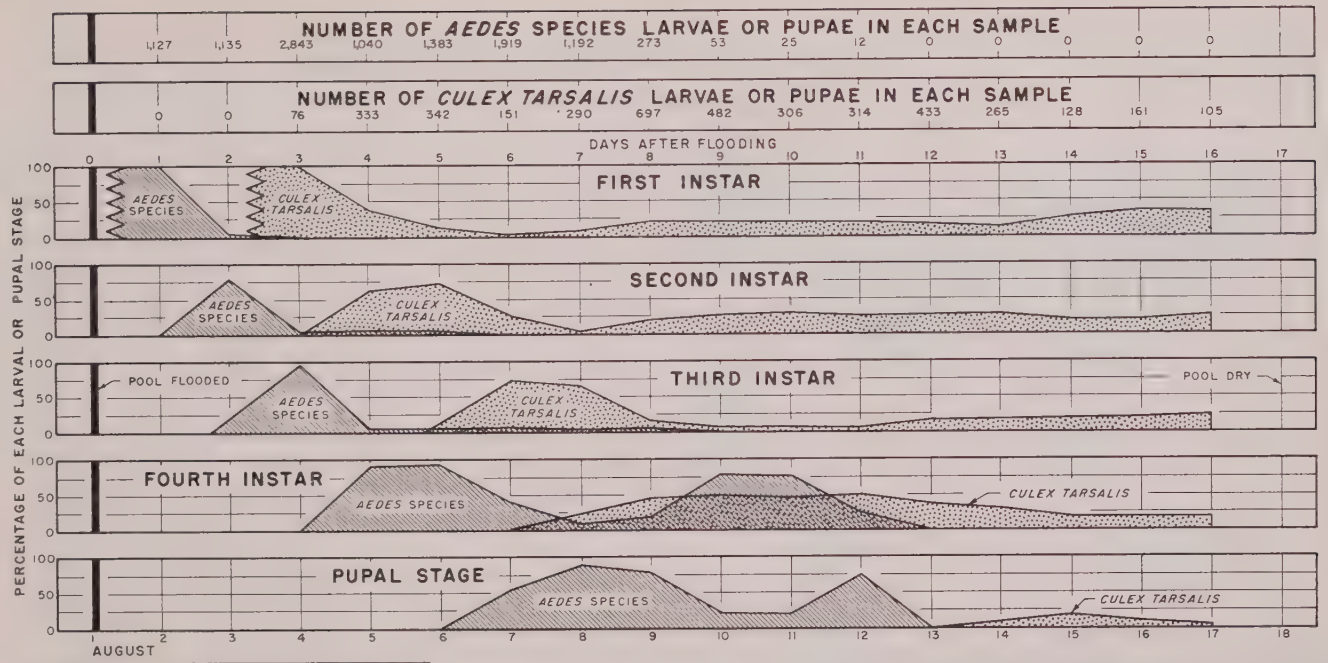


Figure 3. Rates of development of *Aedes dorsalis*, *A. vexans*, and *A. nigromaculis* as determined by collections made at 6-hour intervals in a surface pool (No. 5-4) near Morrill, Nebraska, August 21–30, 1952.


NUMBER OF AEDES SPECIES LARVAE OR PUPAE IN EACH SAMPLE
1,127 1,135 2,843 1,040 1,383 1,919 1,192 273 53 25 12 0 0 0 0 0
NUMBER OF CULEX TARSALIS LARVAE OR PUPAE IN EACH SAMPLE
0 0 76 333 342 151 290 697 482 306 314 433 265 128 161 105
DAYS AFTER FLOODING
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
FIRST INSTAR
AEDES SPECIES
CULEX TARSALIS
SECOND INSTAR
AEDES SPECIES
CULEX TARSALIS
POOL FLOODED
THIRD INSTAR
POOL DRY
AEDES SPECIES
CULEX TARSALIS
FOURTH INSTAR
AEDES SPECIES
CULEX TARSALIS
PUPAL STAGE
AEDES SPECIES
CULEX TARSALIS
PERCENTAGE OF EACH LARVAL OR PUPAL STAGE
100
50
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
AUGUST

NUMBER COLLECTED AND IDENTIFIED				
SPECIES	FOURTH INSTAR		PUPAE	
	NUMBER	PERCENT	NUMBER	PERCENT
A DORSALIS	3,116	97	2,295	96
A VEXANS	35	2	78	3
A NIGROMACULIS	5	1	14	1
TOTAL *AEDES*	3,156	100	2,387	100
C. TARSALIS	1,252	100	54	100

Figure 4. A comparison of development patterns of *Aedes* species and *Culex tarsalis* as determined by collections made at 24-hour intervals in a surface pool (No. 8) near Morrill, Nebraska, August 1-18, 1952.

salis was collected in the fourth pool). The average time for completion of the larval stage was 6 days for *A. dorsalis* and 5 days for *A. vexans* and *A. nigromaculis* at average air temperatures ranging from 68.9° to 73.4° F. The minimum number of days required for each of these species to reach the fourth-instar and pupal stage in the four pools is shown in table 1.

The brood patterns of *Culex tarsalis*, the only *Culex* present in the habitats studied, were not so well defined as those of the *Aedes* (fig. 4). The eggs of *C. tarsalis* were laid on the water surface and hatching occurred in 2 or 3 days. Because new egg rafts continued to appear in the pool, *C. tarsalis* larvae from different hatchings were intermingled. *Aedes* larvae appeared shortly after flooding and no further aedine hatching occurred unless there was a rise in water level in the pools. *C. tarsalis* larvae gradually increased in numbers as a result of periodic oviposition. In several pools the mosquito fauna changed completely to *C. tarsalis* after the *Aedes* emerged.

Most of the pools dried up before *Culex tarsalis* reached the pupal stage. In the few that retained water long enough for completion of the larval stage, the fourth-instar stage was reached in an average of 7 days after flooding, and pupae appeared in an average of 10½ days, at average air temperatures ranging from 70° to 77° F.

Discussion. Knowledge of the time required for completion of the immature stages of irrigated pasture mosquitoes is important for effective prevention and control of the severe mosquito problems in many sections of the North Platte Valley. Extensive salt grass pastures and hay meadows are irrigated 3 or 4 times during the summer. Because of irregular topography, the fields are irrigated by wild flooding and when enough water is applied to cover the high spots, excessive ponding occurs in the low places. Owing to tight soils, water often stands in the depressions from 1 to 2 weeks, thereby permitting both *Aedes* and *Culex* to complete their aquatic stages. A succession of species occurs with each irrigation, beginning with *Aedes* and ending with *Culex*. Irrigation schedules for individual farms vary so that mosquito production is almost continuous throughout the summer.

Mosquito production occurring on the pastures could be prevented if irrigation and drainage practices that would remove residual irrigation water from the fields and adjacent areas within 5 days after the water is applied were uniformly adopted by the farmers. From the standpoint of chemical control, the rapid growth rate of the larval stadia of *Aedes* limits the time available for application of larvicides to surface water collections. Since the first three instars are more susceptible to larvicides, these materials should be applied within 3 days after the pastures are flooded.

Summary. Data on mosquito larval development were obtained from 14 temporary pool sites in salt grass pastures in western Nebraska, 1952. The larval growth rates of mosquitoes in the pools studied varied with the temperature, growth periods becoming shorter as the average air temperature increased. The minimum time for *Aedes dorsalis* to complete the larval stage was 5 days, *A. vexans* 4½ days, and *A. nigromaculis* 4 days at average air temperatures between 72° and 77° F. In two pools, where the larval populations differed greatly, the development rates of the first three instars were about the same; however, in the pool where higher larval populations prevailed, a greater percentage of the larvae remained in the fourth instar for a longer period.

Culex tarsalis reached the fourth instar in an average of 7 days after flooding, and the pupal stage in 10½ days at average air temperatures between 70° and 77° F. After the pools were flooded, *C. tarsalis* larvae usually appeared in 2 or 3 days and the population density gradually increased as a result of periodic oviposition.

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MERMITHID NEMATODE PARASITES IN MOSQUITOES[1]

D. W. JENKINS[2] AND A. S. WEST[3]

In the arctic and subarctic regions where mosquitoes are very abundant but the larvae are widely dispersed and not concentrated, chemical control methods have generally given results of limited value. In these areas natural control methods using parasites or predators would be most valuable if made practical.

Mermithid-type nematodes were discovered emerging from mosquito larvae at Churchill, Manitoba and Coral Harbor, Southhampton Island, Northwest Territories by the authors during the summer of 1950. Additional collections were made by West the following summer at Churchill.

Nematode infested fourth-instar mosquito larvae appeared to have the thorax, or abdomen, or both, whitish and swollen. Most frequently the nematodes were observe to be coiled inside of the thorax just below the integument. They were also coiled evenly in the first and second abdominal segments. Occasionally specimens were observed irregularly coiled in the thorax, irregularly coiled in the thorax and abdomen, or entirely within the abdomen, doubled back several times. Infested mosquito larvae were usually slower moving and frequently were covered with a dense mass of epizootic protozoans (*Vorticella*-type) and algae. Such growth was also commonly found on larvae uninfested by nematodes, but it occurred in smaller quantities.

Larvae of *Aedes communis* (DeGeer) were the most frequently infested. In two pools at Churchill in 1950 up to 100 per cent of the late developing larvae were infested and died. No larvae of *A. excrucians* (Walker) in these same pools were observed to be infested. Parasitization was most severe during the latter part of the larval season in early July. Nematodes in *A. communis* larvae were collected on 18 June, and from 5 to 18 July, 1950, and from 19 June to 4 July, 1951. An infested larva of *A. nearcticus* Dyar was collected at Coral Harbor, Southhampton Island on 3 July, 1950. An infested larva of *A. nigripes* Zett. was collected at Churchill in June, 1951.

[1] These studies are a part of a program of investigation of biting flies of the Canadian North sponsored by the Defence Research Board of Canada and the Division of Entomology, Science Service, Canada Department of Agriculture.

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The nematodes normally emerge from the larval thorax by breaking through the side or bottom of the integument, leaving a large cavity. Partial emergence of the worms through the anus and through the air tube were observed, but both the worms and larvae died. No infested mosquito larvae pupated.

While the nematodes are emerging the larvae writhe and exhibit spasmodic movements and jerks. After emergence of the nematode, the larvae continue jerking motions and die almost immediately or within a few hours. One larva was observed to die after 2.5 hours.

There is usually one nematode per mosquito larva, but multiple infestations are common. In 1951 a sample of 84 infested mosquito larvae *(A. communis)* was placed in a beaker and 34 died without emergence of the parasites. From the 50 remaining larvae, 167 worms emerged, averaging 3.3 per larva. Larvae have been collected containing 1, 2, 3, or 4 nematodes. In the mosquito larvae when only one worm occurred it usually developed into a female, and when more than one occurred more males developed.

A series of nematodes, together with hosts, was preserved in alcohol for identification. Several hundred nematodes from field collected larvae have been observed in the laboratory. Worms were put in rearing beakers containing water or water and sand or organic materials. A few nematodes were put in water with *Daphnia*. Other nematodes were allowed to emerge in containers with water and sand and thus were not subjected to handling.

After leaving the host or being placed in a container, the nematode moved to the bottom and entwined around bits of debris or formed an entangled mass with other worms. When the substrate was sand the worm usually anchored itself at one end and slowly moved the anterior (presumably) end through the water in a whip-like motion.

After about a month at room temperature all worms died and decomposed. Where sand was furnished nearly all worms burrowed into the sand during a period of two to three weeks and rested in a coiled position. When containers with worms were held in a refrigerator at approximately 6° C., the same behavior was observed except that a few individuals remained active on the surface of the sand for three to four months and resting, coiled individuals did not decompose until after three to four months.

No eggs were discovered in any container. The contents of some containers were allowed to dry at room temperature and the water level was maintained in other containers in a refrigerator and at room temperature. At intervals after eight to twelve months from time of emergence from the host, water and *A. aegypti* (L.) larvae were added to dry sand and wet sand was placed in *A. aegypti* rearing pans. No pre-parasitic larvae were observed and no nematode infestation of mosquito larvae occurred.

Beginning with the 1952 season the study of this mosquito larval parasite was turned over to the Laboratory of Entomology, Science Service, Canada Department of Agriculture, Belleville, Ontario. Field observations and attempts at laboratory rearing are being continued.

The writers interpreted the emerging worms from mosquito larvae to be immature. This has been confirmed by Dr. G. Steiner, Division of Nematology, U. S. D. A., Beltsville, Md., to whom preserved material was submitted for identification. According to Dr. Steiner (1951) the parasite belongs to the nematode family *Mermithidae* and is a new species of the genus *Hydromermis* which he is describing. One of the specimens is a pre-adult female and exhibits a vulva opening. These worms have only one host. Development to the adult stage must then be completed as a free-living form. In nature the adult worms may be found under stones and plant debris or in the mud.

Parasitic nematodes were observed by Freeman (1950) to be the chief enemy of mosquito larvae at Frobisher Bay, Baffin Island in 1948.

"The worms were found in any type of pool and infested up to sixty per cent of the larvae in some pools. The worms lie coiled under the thoracic cuticle and form four rings around the oesophagus. This causes the thorax of the larva to appear swollen and the larva appears superficially to have a white-ringed thorax. Most of the parasites had completed their development within the mosquito larvae by June 28. They emerge from the larva at the side of the thorax and the larva dies immediately after the worm emerges. These worms appear to emerge simultaneously and congregate in little knots or groups at the bottom of the pools where they later bore into sand, gravel, etc."

In French Guiana, nematodes were found in pairs, one large and one small worm, in the body cavity of *A. aegypti* by Gendre (1909). The larvae developed normally but just before pupation the worms left the host at the posterior end of the body by perforating the membrane surrounding the anus. The larger worm emerged first followed by the smaller and both died several hours later. The mosquito larvae died as a result of injuries. The parasitized larvae were collected from water in cavities in trees. No parasitized adults were found.

The life cycle of the mermithids is known to be reversed from that of the usual life cycle of parasitic nematodes. In *Mermis* and other genera the larvae are parasitic in insects, while the sexual stages are free living in soil or water (Borradaile *et al.*, 1935, p. 256.). According to Muspratt (1945) nematodes other than *Filaria,* parasitic in mosquitoes have been recorded from the United States, Canada, Europe, Russia, India, Ceylon, Sumatra, and Africa. These mermithids were *Limnomermis* Daday, *Paramermis* Linst, *Mermis* Duj. and *Agamomermis* Stiles. The latter is an artificial collective group for larvae which cannot be identified.

In Pennsylvania, larvae of *Aedes vexans* Meigen and *Culex salinarius* Coq. were found by Stabler (1945) on 11 August to be parasitized by a mermithid nematode. Up to 100 per cent of some collections of *A. vexans* larvae were found to be parasitized and all infested larvae died after emergence of the worm. Infested *C. salinarius* Coq. larvae were found in the same collections (Stabler, 1951). Of 217 larvae 90 were infested. The measurements of the worms ranged from 9 mm. to 18 mm. averaging 14.7 mm. Sections of the thoraces of the infested larvae showed that the worms lay coiled and twisted in the haemocoele just under the exoskeleton and encircling the internal thoracic structure. No gross anatomical changes were correlated with the presence of the parasite internally. One larva contained three small worms, the others only one.

The life cycle of the mermithids that destroy mosquito larvae was studied in India by Iyengar (1927). He found that the minute pre-parasitic worms swim in the water and probably penetrate the cuticle of the mosquito larvae. The smallest nematodes seen in the mosquito larval haemocoele were 650 to 700μ in length and 115 to 165μ in width. The parasitized mosquito larvae were found to remain as 4th instar longer than normal larvae. The larvae died on emergence of the nematodes. Muspratt (1945) found that both sexes and one or more individuals may parasitize a single mosquito larvae. The nematodes enlarged after emerging.

About 100 nematode larvae which had just emerged from mosquito larvae were put in a jar containing sand and water (Muspratt, 1947). The larvae burrowed into the sand and became dormant after a few days. The water was decanted and the sand was kept moist for 11–12 months. Some sand was then transferred into a jar containing over 100 *A. aegypti* larvae. Within 24 hours some of these contained small nematodes in the haemocoele and pre-parasitic larvae less than 1 mm. in length were seen swimming in the water. After 70–80 per cent were infected, new mosquito larvae were exposed. Nematode eggs hatched during 2 to 3 weeks. The nematodes emerged from the mosquito larvae after 10 to 14 days. Apparently the nematodes emerging from mosquito

larvae mature and lay eggs in sand and require 11 or 12 months before hatching, although the similar mermithid studied by Iyengar (1927) had a much shorter cycle.

The methods of dispersal of these nematodes is at present unknown, but it is of interest to note their presence in water in tree holes as well as in temporary vernal ground pools throughout the world.

A number of observers have reported nematode parasitism of adult mosquitoes as well as in the immature stages.

At Leipzig, Germany, *Agamomermis* sp. were collected in the abdominal cavity of larvae, pupae, and adults of *Culex nemoralis* by Stiles (1903). Infestation was thought to have occurred in the water. The infested insects were very sluggish in movement and many of them died from the effects of the parasite. The ovaries of parasitized females were underdeveloped and during the years when the nematodes were most common the mosquitoes were less numerous.

In New Jersey, Smith (1904) collected large numbers of female *Aedes sollicitans* (Walker) which were infested with *Agamomermis culicis* Stiles (1903) from 25 June to 25 September, 1903. Up to 50 per cent of the specimens collected contained worms. The peak of infection occurred in late July and into August. The ovaries of *A. sollicitans* did not develop when the female was parasitized and the nematode was considered to be a material check on this species. Parasitized adults were collected far inland from the coast. The presence of the parasite did not prevent the females from feeding.

The species of mosquitoes recorded to be infested with mermithids include:

Mosquito	*Stage*	*Locality*	*Authority*
Aedes aegypti (L.)	L	Africa	Gendre (1909), Muspratt (1945)
A. aldrichii D. and K. (= *A. sticticus* (Meig))	A	North America	Hearle (1929)
A. calecatus Edw.	L	Africa	Muspratt (1945)
A. cantans Meig. (= *A. stimulans* (Walker)?)	A	Russia	Shakhov (1927)
A. communis (DeG.)	L	North America	Jenkins and West
A. dorsalis (Meig.)		Russia	Shakhov (1927)
A. flavescens (Müller)	A	North America	Hearle (1929)
A. fulgens Edw.	L	Africa	Muspratt (1945)
A. haworthi Edw.	L	Africa	Muspratt (1945)
A. marshalli Theo.	L	Africa	Muspratt (1945)
A. metallicus Edw.	L	Africa	Muspratt (1945)
A. nearcticus Dyar	L	North America	Jenkins and West
A. nemorosus Meig. (= *A. communis* (DeG.))		Europe	Stiles (1903)
A. nigripes Zett.	L	North America	West
A. sollicitans (Walker)	A	North America	Stiles (1903)
A. zethus DeMeill	L	Africa	Muspratt (1945)
A. vexans Meig.	L	North America	Stabler (1945)
		North America	Steiner (1924)
Anopheles gambiae Giles	L	Africa	Muspratt (1945)
A. leucosphyrus Dön	L	Sumatra	Walandouw (1934)
A. rufipes Gough	L	Africa	Muspratt (1945)
A. spp.	L	India	Iyengar (1927)
Culex nebulosus Theo.	L	Africa	Muspratt (1945)
C. nemoralis Stiles (probably = *nemorosus* = *A. communis* (DeG.))	L, P, A	Europe	Stiles (1903)
C. pipiens L.	L	North America	Stabler (1951)
C. salinarius Coq.	L	North America	Stabler (1945)
C. fatigans Wied.		India	Ross (1898)

Hearle (1926) reported that as many as 80 per cent of *Aedes vexans* Meig. mosquitoes in the Fraser Valley, British Columbia in 1920, contained a parasitic nematode, *Paramermis canadensis* Steiner (1924), but only about 20 per cent in 1921. The effect of the parasite was retardation of the development of the ovaries, since no parasitized females contained well-developed eggs. The largest worm measured 1.25 in. in length, and there were from one to six present in a single mosquito. A single female *Aedes aldrichii* D. and K. was found parasitized but no effect on egg development was apparent. It was stated that there was little doubt that the parasite considerably reduced the numbers of *A. vexans*. Hearle (1929) found an adult female *Aedes flavescens* (Müller) in Canada to be parasitized by a single small nematode.

Bates (1949) refers to mosquitoes being hosts during part of the life cycle of numerous filarial worms and reports that the filaria often cause considerable injury to their mosquito hosts. He also states that many mermithid nematodes have been reported from mosquitoes and that little is known concerning their biology. A number of references on the occurrence of filaria and mermithids in mosquitoes have been compiled by Speer (1927).

Steiner (1924) states that "many observations and facts support the theory that the members of the nema family of Mermithidae (which includes a series of different genera with at least several hundred species), play a much more important role than might have been expected in the control of many kinds of insects."

SUMMARY

Parasitic mermithid nematodes were discovered infesting the larvae of three abundant species of arctic mosquitoes. All of the infested mosquito larvae died and up to 100 per cent infestation of *Aedes communis* was observed in one pool. Observations were made of the habits of the nematodes and rearing was attempted.

It appears that mermithid nematodes offer an effective means of natural control if they can be reared in large numbers. This subject deserves detailed investigation, particularly the development of a suitable method of rearing and disseminating the parasite.

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THE IDENTIFICATION OF THE LARVA OF *PSOROPHORA (GRABHAMIA) SIGNIPENNIS* (COQUILLETT)

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INTRODUCTION. The usual published description of the fourth instar larva of *P. signipennis* states that the upper and lower head hairs are single. The writer has observed that a rather large percentage of specimens of this species collected in the southwest exhibit a varying number of branches of these head hairs. To the knowledge of the writer all but two of the previously published descriptions of this species state that the upper and lower head hairs are single, and these characters are usually used as a major point of differentiation of the species found in the United States. (Howard, *et al.*, 1912; Dyar, 1928; Carpenter, 1941; King, *et al.*, 1944; Matheson, 1944; Randolph and O'Neil, 1944; Carpenter, *et al.*, 1946; Pratt, 1946). Rozeboom (1942) states that the lower and upper head hairs are either single or double and uses other characters to distinguish the larva of this species. Yamaguti and LaCasse (1951) state that the lower head hairs are one to three forked and the upper head hairs are single.

THE PRESENT STUDY. The writer has examined over 400 specimens of this species from various localities in the southwest and 29.9 per cent of these specimens had at least one of the head hairs double or triple. This variation in number of branches of the head hairs occurs in both the upper and lower hairs with equal regularity. Some of the specimens examined had one hair double or triple, some two, others three, and less than one per cent of the total 29.9 per cent had all hairs not single. The following briefly summarizes the head hair variation observed.

It should be noted that many specimens examined varied from the usual published description in other characters, such as the number of comb scales and the number of pecten teeth. Larvae having as few as four and as many as eight comb scales and as few as two and as many as eight pecten

Locality	No. examined	No. with head Hair variation	Percent
Austin, Texas	144	22	15.3
Palmetto State Park, Texas	10	4	40
Sonora, Texas	16	2	12.5
Fort Sill, Oklahoma	50	24	48
Camp Bullis, Texas	160	25	15.6
Fort Hood, Texas	50	24	48
Total	430	101	

(Collections examined which consisted of less than ten specimens were not included in the above.)

teeth have been observed. Most of the previous descriptions of this species state that six comb scales and from four to six pecten teeth are present.

A species frequently confused with *P. signipennis* is *P. (Janthinosoma) cyanescens* (Coquillett). Rozeboom (1942) uses the dorsal preapical spine of the siphon as a character for distinguishing between the two species. This hair is quite short in *signipennis* and rather long in *cyanescens*. King, *et al.*, (1944) report a *signipennis* fourth instar larva from Mercedes, Texas, in which the dorsal preapical spine is quite a bit longer than the usual case. They distinguish between *signipennis* and *cyanescens* on the basis of the preantennal and antennal hair tufts. *Signipennis* has these tufts multiple and strongly feathered while *cyanescens* has them two to three branched and weakly feathered. King, *et al.*, report the dorsal preapical spine of their specimen to be about two thirds as long as the dorsal preapical spine of *cyanescens*, and therefore this feature could theoretically be used to distinguish between the two. The writer is of the opinion, however, that comparative characters are of limited value in taxonomy as one must always have the other species to which the comparison is made to make an accurate identification. Yamaguti and LaCasse (1951) use characters of the "cutting organ" of the mandible to distinguish between *signipennis* and *cyanescens*. The cutting organ of the mandible of *signipennis* has two pectinate blades followed by a pectinate seta while this organ in *cyanescens* has one pectinate blade followed by two pectinate setae. The characteristics of this structure are rather difficult to see in permanently mounted slides, but they have proven helpful in personal observations of freshly-killed, unmounted larvae. The writer believes, however, that the preantennal and antennal hair tuft characters are the best criteria for separating the two species.

The question normally arises whether there is a possibility of confusing larvae of *P. (G.) confinnis*, which has multiple head hairs, with one of P. *signipennis* possessing variable head hairs. As stated previously very few cases of all the head hairs of *signipennis* being other than single have been noted. In none of the above mentioned cases have more than two of the individual hairs been triple. There is little possibility that the two species would ever be confused since both upper and lower head hairs of *P. confinnis* have three to six branches.

Some difficulty could occasionally arise in distinguishing *P. (J.) ferox, P. (J.) longipalpus, P. (J.) horrida,* or *P. (J.) varipes,* from an apparently rare *signipennis* having all head hairs double. Such difficulty could be quickly resolved by the use of the length of the antennae and the degree of inflation of the siphon. *Signipennis* has antennae shorter than the head and a siphon only slightly inflated. On the other hand, the above mentioned species all have antennae as long as or longer than the head and the siphon strongly inflated. It should be noted that variation in the number of branches of the head hairs of *signipennis* has been observed only in the fourth instar.

In the examination of numerous fourth instar specimens of all species in this genus found in the United States, with the exception of *P. varipes* and *P. horrida* of which only a few have been personally examined, the writer has observed frequent and obvious variations in most of the species. Most of these variations are of no consequence in the determination of the species, but when variations of specific characters occur, such as the head hairs of *signipennis*, the aspect of the problem changes. The investigator should learn to consider each larva of the species of this genus he encounters as an individual rather than as a carbon copy of the printed description. If there is any doubt relative to the larval determination, the adult male or female should be examined if possible.

SUMMARY. Most of the published descriptions of the larva of *Psorophora signipennis* state that the upper and lower head hairs are single. These features have

been frequently used to differentiate this from other species. The writer has found that a rather large percentage of the specimens of this species collected in the southwest exhibit a varying number of branches in the head hairs. This frequently makes it difficult or impossible for the investigator unfamiliar with the genus to make an accurate and positive identification. The other species of the genus that are apt to be confused with *P. signipennis* in the larval state are discussed along with suggestions for distinguishing between them.

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ECOLOGICAL CONDITIONS WHICH INFLUENCE CONTROL OF MOSQUITO-LIKE NUISANCE PESTS (TENDIPEDIDAE)

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Prior to the advent of chlorinated hydrocarbon insecticides the few efforts made to control midge infestations in open bodies of water met with questionable success. This was due in part to the lack of detailed information relative to the habits and the development of even the more common species of the group—and in part to the attempted adoption of the early mosquito control oiling method for midge control. Since the midge immature stages possess gill-like respiratory appendages and procure their oxygen directly from the water in which they live, periodic surfacing is unnecessary. Under these conditions the possibility of larval contact with surface oil is so remote that its potentialities as an effective larvicide are practically nil. Likewise, in adult emergence, where the pupa rises directly from the bottom mud to the water surface and the adult escape there is nearly instantaneous, surface oil does not appear to be an effective adulticide. In more recent years a variety of methods have been utilized in midge control. The type of treatment selected to combat any particular species is dependent upon the habits of the specific pest and the existing chemical and physical characteristics of its environment.

While misting and fogging have pro-

duced excellent temporary control, the most economical and most effective treatments have resulted when the toxic materials have been applied as larvicides. Dispersal of small quantities of emulsified chlorinated hydrocarbon insecticides throughout the water habitat have been successful: (1) where existing physical conditions favor retention of the insecticide over the period of time necessary to provide a residual effect; and (2) where the chemical qualities of the water provide a pH which is compatible with the insecticide. To date, no standard method has been formulated which may be successfully applied to all midge breeding areas. To illustrate the variation in control measures necessitated by the divergence: (1) in the habits among species; and (2) in the chemical and physical factors encountered in the various breeding media—three outstanding midge control problems and their solutions have been selected for discussion.

MUSQUASHIAT POND—This 74-acre brackish pond with an average depth of 2.5 ft. is separated from the open ocean only by a 150-ft. wide shingle beach. The chloride content of the water varies from 2700 to 4500 parts per million, the pH of 7.82 is probably due to the presence of *Chara* which is a lime secreting plant, and the strong hydrogen sulphide odor of the bottom mud is due to the presence of sulphur reducing bacteria. An outlet on the inland side of the pond discharges into a short improved brook which flows westerly into the main creek of an inland salt marsh. Only extreme high tides reach the pond through this natural outlet. Losses from the pond, through the natural drainage outlet or by evaporation, are replaced by surface drainage from the watershed with an area of 0.9 square mile. Aquatic growth other than *Chara* includes species of *Potamogeton* and *Enteromorpha* which are rooted to the bottom; and *Cladophora,* a filamentous green algae, which forms a heavy scum on the water surface. The small midge, *Apedilum elachistus* Townes, develops in the aquatic vegetation and although three peaks of emergence are evident i.e., second week of May, first week of July, and third week of August—a rather dense population persists throughout the intervening periods to produce a continuous nuisance from May to late October. Because of its diminutive size this pest passes readily through most window screening into the interior of homes where it creates an obnoxious condition. In 1953, as the result of increased real estate development in the area, control treatments were restricted to the pond proper. On May 7 the pond was treated with 14 lbs. of Rhothane * (technical grade) dissolved in 60 gals. of orthodichlorobenzene to provide a dosage of one part Rhothane to 30 million parts of water. The application was made with a manually propelled flat bottomed skiff equipped with a 30-gallon pressure tank and a 10 ft. boom rigged over the stern. The tank and boom were connected by flexible copper tubing with a shut-off valve inserted in the line. When the equipment went into operation the boom was adjusted to place the .062 nozzles, carried by 6-inch off-sets at either end, from 2 to three inches below the water surface. This provided an injection effect in contrast to the regular surface spraying method. The insecticide solution was divided to make three equal loads of about 20 gals. each. This allowed about one-third of the tank capacity for an air load. At the beginning of each application the air pressure in the tank was built up to 100 lbs. per sq. in. and remained above 80 lbs. per sq. in. throughout each injection period. No residual effect was anticipated because of the high alkalinity (pH 7.82) which tends to destroy the toxic qualities of chlorinated hydrocarbon insecticides. The solvent, orthodichlorobenzene, with a specific gravity of 1.415 was selected to facilitate rapid settling of the solution and subsequent contact with the submerged vegetation in which the pest breeds. As a result of this treatment the *Apedilum elachistus* larvae and pupae were destroyed. However, the eggs existing at the

* Rhothane contributed by Rohm & Haas Co.

Top: Musquashiat Pond—showing green algae masses which harbor *Apedilum elachistus.*

Middle: Merrimack River—showing sludge flats or breeding medium for *Glyptotendipes lobiferus.*

Bottom: Weston Swimming Pool—source of infestation of *Tendipes viridicollis.*

time of treatment survived to produce a second generation of adults which began to appear during the first week of the month of July following the control operation.

MERRIMACK RIVER—During the summer of 1950 a major midge nuisance occurred along the heavily polluted Merrimack River, particularly in the ponded section at Merrimacport where this active stream is nearly 2,000 ft. in width. A preliminary study of the environmental conditions showed that the chloride content of the water varied from 14 to 113 ppm, that the pH averaged 6.9, and that the BOD was sufficient to exclude all fish life. Both green and blue-green algae formed small scattered masses on the water surface—masses of *Oscillatoria* being the most prevalent. Water weeds were absent with the exception of *Sagittaria* which formed a dense vegetative mat along the river banks at the high tide line. Although the ledgy bottom of the stream bed was comparatively free of sediment, as the result of constant scouring by the strong current, extensive sludge flats were present in the quiet water adjacent to the river banks. Due to the fluctuation of the water level, which is a reflection from the tidal action at the mouth of the stream, these flats were almost completely exposed each day during the ebb tide periods. Immature stages of the midge *Glyptotendipes lobiferus* were found concentrated in the river flats composed primarily of partially digested organic sludge, although a few larvae were dredged up from small masses of sludge located in the channel at a 22-ft. depth. In the winter and early spring of 1951, larvae were not found above the low water line until after May first, when they again became numerous in the upper portion of the sludge flats. Information gained during the preliminary study indicated the probable success of a control program organized to take advantage of two outstanding environmental conditions as follows: (1) the restricted distribution of the larvae and pupae to the sludge flats located along the river banks; and (2) the exposure of these flats at each ebb tide period. Under the existing conditions, it appeared obvious that any control treatment should be limited to the sludge flats. On June 12 and 13 when pupae began to appear in quantity, New Jersey larvicide diluted with river water (1–5) was applied at the rate of 25 gals. of finished spray per acre. The river spraying equipment, borrowed from the East Middlesex Mosquito Control Project, consisted of a small flat bottomed skiff in which a Pacific-Marine fire pump had been mounted at rail level, and an open topped insecticide tank carried in the skiff; also two sizes of extension hose, the larger leading from the pump, the smaller from the insecticide tank, with both terminating at a common mixer nozzle. In operations, the major portion of the river water delivered by the pump was diverted to a water jet at the stern, and this contrivance provided propulsion for the spray rig. The remaining water from the pump passed through the larger extension hose to the affixed nozzle, where it was mixed with New Jersey larvicide drawn by suction through the smaller hose leading from the insecticide reservoir. When the pyrethrum emulsion came in contact with the water saturated flats it diffused readily throughout the surface sludge with the following results: (1) emergence of larvae from the harboring medium in from 1 to 3 minutes; and (2) total paralysis of the larvae within 5 minutes. Observations made on the 18th and 22nd of June indicated that the mortality had approximated 99 per cent. However, re-examination of the flats one month after spraying produced evidence of re-infestation. As a consequence, a second application was scheduled for the 24th and 25th of July. Periodic collections taken from the flats during the following August and September indicated a definite scarcity of *Glyptotendipes* larvae in the sludge. As an additional check on the control method, the adult population density was measured weekly by light trap collections taken from May through October. During the following summer (1952) no complaints were re-

ceived relative to the presence of this pest. However, in late August of 1953 this midge again became moderately numerous and residents of the Merrimacport area petitioned for a repetition of the 1951 treatment for the spring and early summer of 1954.

Weston Swimming Pool—This municipal pool actually represents a natural spring-fed pond which has been converted into a sanitary bathing pool with a refill outlet from the domestic water supply. In constructing the pool, the bottom mud was removed and replaced with a layer of gravel which in turn was covered with a finished layer of beach sand. More than one-half of the pool area, with a depth varying from 1½ to 3 ft., was restricted as a wading area for small children—while the basin-like northern end, with a depth of 10 ft. and flanked by a concrete retaining wall equipped with spring boards and similar appurtenances, was designed to accommodate the teen-age group. The completed pool has a capacity of 700,000 gals., a width of approximately 100 ft., a length of 325 ft., and a total area of ¾ of an acre. During the third season of operation (1953) the midge *Tendipes viridicollis* became sufficiently numerous to constitute a minor nuisance, particularly in regard to pupal skins which accumulated on the water surface and presented an unsightly appearance. After the pool had been closed, a brief study was conducted to determine whether a simple treatment might be devised to eliminate this pest. Observations made in late September disclosed that small patches of organic matter were scattered about the sandy bottom and that these were harboring midge larvae. On the 10th of October, after egg laying had apparently ceased, it was noted that the majority of the larvae had deserted the organic material to burrow into the sandy bottom. On the 11th of October, the pool was treated with 6 per cent Rhothane emulsion at the rate of 1 part Rhothane to 20 million parts of water. The insecticide was applied by spilling small amounts from a bucket into the pool at several points along the periphery. Although the embedded larvae exhibited no discernible reaction to the toxic material on the day of treatment, by the early part of the following day (12th of October) or after 24 hrs. contact, the majority had emerged from the sand and a high percentage had succumbed to the treatment while a few still displayed slight convulsive movements. This treatment demonstrated the lethal effect of Rhothane on midge larvae embedded in the sandy bottoms of pools or similar bodies of water.

In conclusion, recent midge control investigations have demonstrated: (1) that a Rhothane-orthodichlorobenzene solution injected below the water surface at the rate of 1 part Rhothane to 30 million parts of water will destroy the immature stages of the water weed inhabiting midge *Apedilum elachistus* despite an existing alkalinity sufficient to eliminate all residual effect; (2) that Rhothane emulsion applied at the rate of 1 part Rhothane to 20 million parts of water will destroy the larvae of *Tendipes viridicollis* embedded in the sandy bottom of a pool where the water is nearly neutral; (3) that New Jersey larvicide will destroy immature stages of *Glyptotendipes lobiferus,* embedded in intermittently exposed sludge flats, when diluted with 5 parts of water and applied to the bare flats at the rate of 25 gals. of finished spray per acre.

PICTORIAL KEYS TO THE MOSQUITOES OF MEDICAL IMPORTANCE[1]

VII. SPAIN AND PORTUGAL

RICHARD H. FOOTE

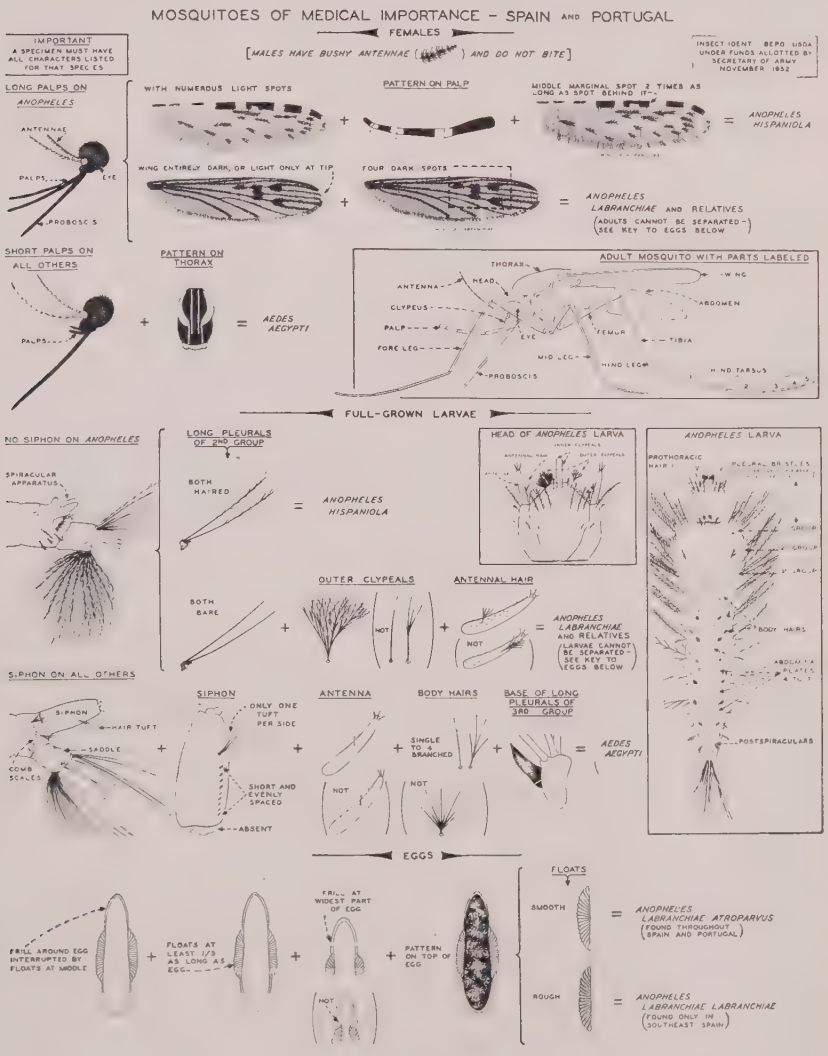
Entomology Research Branch, Agricultural Research Service,
United States Department of Agriculture

The Department of the Army, through a transfer of funds to the Entomology Research Branch, is developing a series of pictorial keys to the mosquitoes of primary medical importance in various areas throughout the world. The keys are designed primarily to assist public health workers in rapidly separating and identifying mosquito species, and are so constructed that they separate the important species not only from each other but also from all other species known to occur, or suspected of occurring, in the area. Keys for several areas have appeared in past issues of *Mosquito News* (vol. 13, nos. 1, 2 and 4; vol. 14, nos. 1 and 2); those appearing below continue this series. Suggestions and comments will be welcomed, especially from those who have firsthand information of the faunas of the various areas, since there are serious gaps in our knowledge of the occurrence and ability as vectors of disease of mosquitoes in many areas.

The species of *Anopheles* known definitely to occur in Spain and Portugal or thought to occur in this area, are: *algeriensis, claviger, hispaniola, hyrcanus* (variety not known with certainty), *labranchiae atroparvus, labranchiae labranchiae, maculipennis maculipennis, marteri, melanoon melanoon, melanoon subalpinus, multicolor, plumbeus, sergentii* and *superpictus*. Of these, only three are of primary importance in the transmission of malaria. One of these, *A. hispaniola,* occurs throughout the southern half of the peninsula and the Canaries, and has been incriminated principally by epidemiological evidence. In Tenerife and the Grand Canaries it has been the only *Anopheles* occurring in the presence of intense malaria. The larvae prefer clear, sunlit water in either small pools or slow streams, nearly always in association with *Spirogyra*. Little is known of the biting habits of the females. By far the most important vectors in Spain and Portugal, however, are *A. labranchiae labranchiae* and *A. labranchiae atroparvus*. The former species, an important vector in many parts of Europe, is restricted to the southeast corner of Spain. In this area it occurs in the almost complete absence of other species of *Anopheles* and transmits a malaria whose endemicity is much higher than in other parts of Spain. Larvae occur in numerous habitats, including fresh water of rice fields and streams as well as brackish coastal marshes. Females enter houses in large numbers to engorge on human blood. In contrast to *A. labranchiae labranchiae,* often stated to be a vector of "intense" malaria, *A. labranchiae atroparvus* is one of "extensive" malaria, being the most widespread mosquito in Spain and Portugal. Larvae typically occur in brackish water along coastal areas, but may be found in fresh water further inland as well. Adults may feed on sheltered animals but prefer the blood of man and are responsible for so-called "winter house malaria."

Aedes aegypti is the only one of the 29 non-anopheline mosquitoes occurring in this area known to be a disease vector. It transmits urban yellow fever and proliferates in close proximity to man, breed-

[1] Keys were drawn by Sally D. Kaicher.


MOSQUITOES OF MEDICAL IMPORTANCE – SPAIN AND PORTUGAL
IMPORTANT
A SPECIMEN MUST HAVE ALL CHARACTERS LISTED FOR THAT SPECIES
FEMALES
[MALES HAVE BUSHY ANTENNAE ( ) AND DO NOT BITE]
INSECT IDENT. BEPO USDA UNDER FUNDS ALLOTTED BY SECRETARY OF ARMY NOVEMBER 1952
LONG PALPS ON ANOPHELES
ANTENNAE
PALPS
EYE
PROBOSCIS
WITH NUMEROUS LIGHT SPOTS
PATTERN ON PALP
MIDDLE MARGINAL SPOT 2 TIMES AS LONG AS SPOT BEHIND IT
= ANOPHELES HISPANIOLA
WING ENTIRELY DARK OR LIGHT ONLY AT TIP
FOUR DARK SPOTS
= ANOPHELES LABRANCHIAE AND RELATIVES
(ADULTS CANNOT BE SEPARATED – SEE KEY TO EGGS BELOW)
SHORT PALPS ON ALL OTHERS
PALPS
PATTERN ON THORAX
= AEDES AEGYPTI
ADULT MOSQUITO WITH PARTS LABELED
THORAX
HEAD
ANTENNA
CLYPEUS
PALP
FORE LEG
MID LEG
HIND LEG
WING
ABDOMEN
EYE
FEMUR
TIBIA
PROBOSCIS
HIND TARSUS
FULL-GROWN LARVAE
NO SIPHON ON ANOPHELES
SPIRACULAR APPARATUS
LONG PLEURALS OF 2ND GROUP
BOTH HAIRED
= ANOPHELES HISPANIOLA
BOTH BARE
OUTER CLYPEALS
NOT
ANTENNAL HAIR
NOT
= ANOPHELES LABRANCHIAE AND RELATIVES
(LARVAE CANNOT BE SEPARATED – SEE KEY TO EGGS BELOW)
HEAD OF ANOPHELES LARVA
ANOPHELES LARVA
PROTHORACIC HAIR
PLEURAL BRISTLES
BODY HAIRS
ABDOMINAL PLATES
POSTSPIRACULARS
SIPHON ON ALL OTHERS
SIPHON
HAIR TUFT
SADDLE
COMB SCALES
SIPHON
ONLY ONE TUFT PER SIDE
SHORT AND EVENLY SPACED
ABSENT
ANTENNA
NOT
BODY HAIRS
SINGLE TO 4 BRANCHED
NOT
BASE OF LONG PLEURALS OF 3RD GROUP
= AEDES AEGYPTI
EGGS
FRILL AROUND EGG INTERRUPTED BY FLOATS AT MIDDLE
FLOATS AT LEAST 1/3 AS LONG AS EGG
FRILL AT WIDEST PART OF EGG
NOT
PATTERN ON TOP OF EGG
FLOATS
SMOOTH
= ANOPHELES LABRANCHIAE ATROPARVUS
(FOUND THROUGHOUT SPAIN AND PORTUGAL)
ROUGH
= ANOPHELES LABRANCHIAE LABRANCHIAE
(FOUND ONLY IN SOUTHEAST SPAIN)

ing in all kinds of artificial containers. Although this disease was last reported in 1890, its vector is included in the key because of the ever-present possibility of the re-introduction of the disease and the large numbers of *A. aegypti* present, especially in the port cities. Dengue fever, likewise transmitted by *A. aegypti*, is present but of an extremely low endemicity.

VIII. WEST INDIES

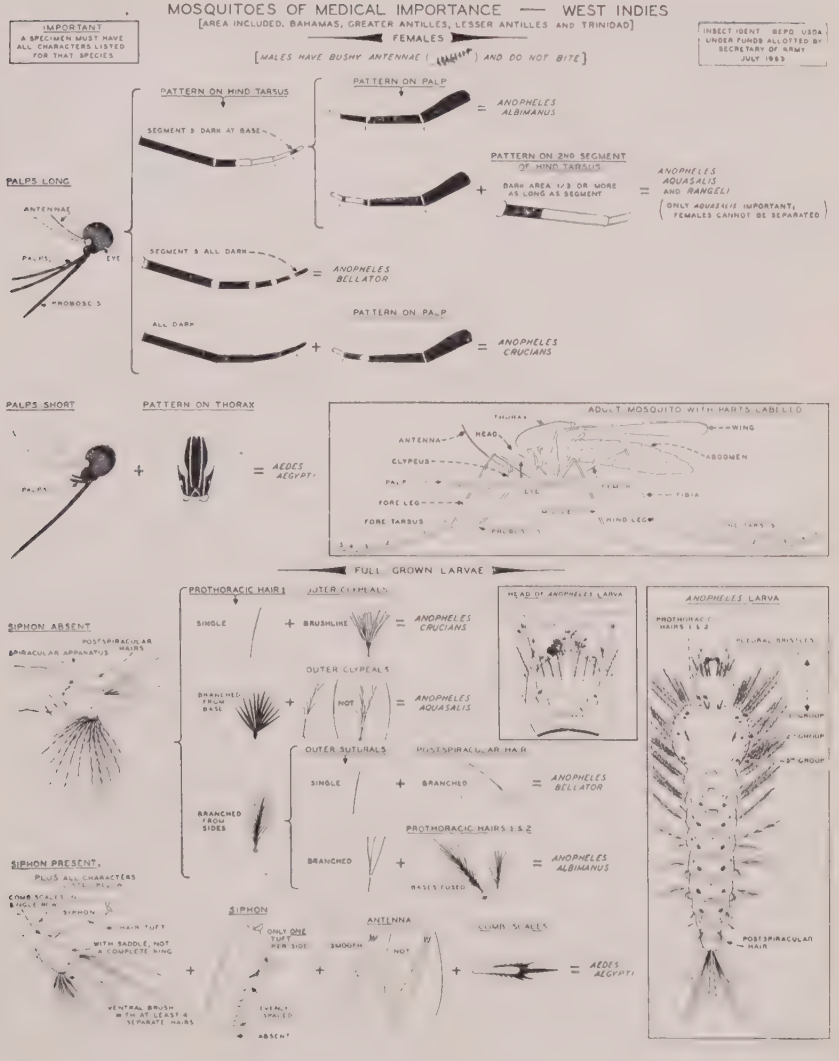
DAVID R. COOK [2]

Of the 20 species of *Anopheles* occurring in the West Indies, only four are important as vectors of malaria. *Anopheles albimanus*, by far the most dangerous, occurs on most of the islands except those lying south of the island of Marie Galante. Larvae occur in a large variety of fresh or brackish water collections in sunlight, and often in tremendous numbers where thick mats of aquatic vegetation are present on the surface. The females of this species attack animals as well as man, but are usually domestic and account for most of the anophelines found in houses. *Anopheles aquasalis*, less important than *A. albimanus* in malaria transmission, occurs principally in the Lesser Antilles and Trinidad. Larvae are found in brackish water along the coast, in swamps, ditches and occasionally in fresh water accumulations. Adults are strong fliers and have appeared in huge swarms far from their breeding places. They definitely prefer the blood of man and enter houses to bite. *Anopheles crucians* is confined principally to Cuba, Jamaica and Puerto Rico. Larvae are found in either fresh or brackish, shaded or sunlit collections of water such as streams, seepages and ponds. Although females enter houses to feed, they will readily bite man out of doors at night. *Anopheles bellator*, the most common anopheline of the cocoa-raising areas of Trinidad, is unusual in that its larvae live in epiphytic bromeliads. Females of this species will enter houses to gain blood meals, but unlike most other anthropophilous anophelines, return immediately to their resting places in the forest, thus making collections of engorged adults very difficult. Adults of this species, like *A. crucians*, will bite out of doors at night.

In addition to the *Anopheles* discussed above, 16 other species also occur, or are suspected of occurring, in the West Indies. There are: *albitarsis, apicimacula, atropos, argyritarsis, eiseni, grabhami, homunculus, maculipes, mediopunctatus, neomaculipalpus, nimbus, oswaldoi, pseudopunctipennis, punctimacula, rangeli* and *vestitipennis*.

Jungle yellow fever is not known to occur in any of the islands of the West Indies. Urban yellow fever, on the other hand, has raged throughout the chain, transmitted by *Aedes aegypti*. This mosquito breeds in all kinds of artificial containers close to human habitations, and is the only one of approximately 117 non-anopheline mosquitoes occurring in the area that is known to be a vector of disease. *A. aegypti* is also a vector of dengue fever, the exact distribution of which is not known with certainty in this area.

[2] Present address: Department of Biology, Wayne University, Detroit 1, Michigan.


MOSQUITOES OF MEDICAL IMPORTANCE — WEST INDIES
[AREA INCLUDED, BAHAMAS, GREATER ANTILLES, LESSER ANTILLES AND TRINIDAD]
IMPORTANT
A SPECIMEN MUST HAVE ALL CHARACTERS LISTED FOR THAT SPECIES
INSECT IDENT. REPO USDA UNDER FUNDS ALLOTTED BY SECRETARY OF ARMY JULY 1953
FEMALES
[MALES HAVE BUSHY ANTENNAE ( ) AND DO NOT BITE]
PALPS LONG
ANTENNAE
PALPS
EYE
PROBOSCIS
PATTERN ON HIND TARSUS
SEGMENT 3 DARK AT BASE
PATTERN ON PALP
= ANOPHELES ALBIMANUS
PATTERN ON 2ND SEGMENT OF HIND TARSUS
DARK AREA 1/3 OR MORE AS LONG AS SEGMENT
= ANOPHELES AQUASALIS AND RANGELI
(ONLY AQUASALIS IMPORTANT; FEMALES CANNOT BE SEPARATED)
SEGMENT 3 ALL DARK
= ANOPHELES BELLATOR
ALL DARK
PATTERN ON PALP
= ANOPHELES CRUCIANS
PALPS SHORT
PATTERN ON THORAX
= AEDES AEGYPTI
ADULT MOSQUITO WITH PARTS LABELLED
THORAX
HEAD
WING
ANTENNA
ABDOMEN
CLYPEUS
PALP
LEG
TIBIA
FORE LEG
FORE TARSUS
HIND LEG
FULL GROWN LARVAE
PROTHORACIC HAIR 1
OUTER CLYPEALS
SINGLE
+ BRUSHLINE
= ANOPHELES CRUCIANS
HEAD OF ANOPHELES LARVA
ANOPHELES LARVA
SIPHON ABSENT
POSTSPIRACULAR HAIRS
SPIRACULAR APPARATUS
BRANCHED FROM BASE
OUTER CLYPEALS
+ (NOT)
= ANOPHELES AQUASALIS
PROTHORACIC HAIRS 1 & 2
PLEURAL BRISTLES
1 GROUP
2 GROUP
3 GROUP
OUTER SUTURALS
POSTSPIRACULAR HAIR
SINGLE
+ BRANCHED
= ANOPHELES BELLATOR
BRANCHED FROM SIDES
BRANCHED
+
= ANOPHELES ALBIMANUS
BASES FUSED
SIPHON PRESENT,
PLUS ALL CHARACTERS LISTED ABOVE
COMB SCALES IN SINGLE ROW
SIPHON
HAIR TUFT
WITH SADDLE, NOT A COMPLETE RING
VENTRAL BRUSH WITH AT LEAST 4 SEPARATE HAIRS
SIPHON
ONLY ONE TUFT PER SIDE
EVENLY SPACED
ABSENT
ANTENNA
SMOOTH
NOT
COMB SCALES
= AEDES AEGYPTI
POSTSPIRACULAR HAIR

EDITORIAL SECTION

The section headed "References to Literature of Interest to Mosquito Control Workers and Malariologists" has been a feature of *Mosquito News* since our earliest days. We believe that it offers a valuable and time-saving service to all who want to know or have to know what is going on in the field of mosquito control, mosquito biology and mosquito-borne diseases.

Miss Helen Sollers now carries on this department, and performs the difficult and time-consuming work not only of ferreting out the references but also of classifying them and preparing the copy for *Mosquito News*.

The editor asked Miss Sollers to prepare some material for the editorial page of this issue. We present her contribution herewith, and recommend it to the attention of all our readers. . . D. L. C.

THE REFERENCE SECTION

Our aim in the bibliography is to obtain a world coverage of papers on mosquitoes and the diseases carried by them. Although this is achieved in part, some of the publications, particularly from Asia, Central and South America are neglected due to our inability to obtain them or references to them. If writers in those parts of the world could send us reprints of their papers or at least a complete reference to them, our quarterly list of references could be improved greatly. In our own country we are in need of publications of various mosquito control associations. It would be most helpful if copies of these publications, reports and reprints could be sent directly to the editor in charge of this department.

Timeliness is an important factor in the bibliography. Our policy is to include only articles published in the current year or previous year unless noteworthy papers from other years are brought to our attention. For this reason it is necessary that we learn of the publication of an article as quickly as possible.

The subject matter of the quarterly list of references covers all phases of mosquito research and control. Mosquito-borne diseases are included but malaria is the only one we attempt to refer to the clinical aspects.

We appreciate the reprints which come to us from a few friends in Asia, Mexico and Canada. Mosquito control agency publications which have been sent to us from members in the United States are also greatly appreciated. But we need additional reprints. We want the bibliography to be more effective and it is only through your assistance that we can accomplish our goal. . . Helen Sollers, Associate Editor (Bibliography)

ASSOCIATION NEWS

SUBJECT: 1955 A.M.C.A.–C.M.C.A. JOINT MEETING*

The wheels are turning on the joint meeting and all parties concerned are getting into high gear. At the recent meeting of the Board of Directors of the California Mosquito Control Association, Inc., that Board adopted motions incorporating the following:

"1. All invitational papers will be printed in the Proceedings (of the C.M.C.A.).

"2. All other papers, authors may choose the method of publication.

"3. All papers over 700 words must be abstracted by the author (i.e., all submitted papers of 700 words or less or abstracts of papers prepared by the author of 700 words or less will be published in the California Proceedings).**

"4. Gardner C. McFarland, Exhibits Chairman, urges all who might exhibit to contact their organizations.

"5. Registration fees for conference set at—Adult, $5.00 (this refers to mosquito control workers and related interested individuals, but not to wives and disinterested guests); Student, $2.00. These do not include dinner dance, but do include free coctail hours."

In order that you will have a clear understanding of who is responsible for conducting the forthcoming meeting, I am including hereunder those designated and their areas of responsibility:

Norman R. Ehmann, formerly of the Los Angeles City Health Department, now employed by the Neil A. MacLean Company, Los Angeles office—designated by the C.M.C.A. as General Chairman of the function, also in charge of local arrangements. Mr. Ehmann in turn has designated—

Dr. John N. Belkin, Associated Professor of Entomology, University of California at Los Angeles, Program Chairman representing the California Association.

Dr. J. L. Truxal, Los Angeles Museum, Assistant to the Program Chairman.

Gardner C. McFarland, Manager of Southeast Mosquito Abatement District, Exhibits Chairman.

W. Earl Duclus, Supervisor of Mosquito Control Field Operations, Los Angeles City Health Department, Assistant on local arrangements.

Harvey I. Magy, Associate Vector Control Specialist, Bureau of Vector Control, Assistant on local arrangements.

Jack H. Kimball, Manager, Orange County Mosquito Abatement District, in charge of special breakfasts.

The team is concluded with the undersigned serving as Program Chairman for the American Association.

Due to a dearth of members of the American Association in the Los Angeles area, it seems judicious to amalgamate entirely in the arrangements responsibilities. Incidentally, this should point out to the A.M.C.A. Membership Committee that the Los Angeles conference will be virgin territory for expanding the Association membership roll.

On September 16–17, I am meeting with Dr. Belkin *et al.* for the purpose of finalizing all aspects of the program in order that arrangements and assignments will be clearly understood and that preparations will be cruising in over-drive. Perhaps Ted Raley will be able to participate in this meeting also.

* From a letter from Dick Peters to President Dorer.

** A motion to this effect has been submitted to the officers and Board of Directors of the A.M.C.A. following approved constitutional procedure.

By way of a bird's-eye look, it is planned that four half-day symposia, featuring encephalitis, mosquito source reduction, chemical control, and mosquito ecology will highlight the second and third days. The first day will be given over to invitational papers, and the fourth day will be a half-day session devoted to miscellaneous aspects of California mosquito control. Concurrent with the symposia will be sessions for reading submitted papers.

This about sums up the situation to date, and I assure you that California will see to it that the joint meeting will he highly stimulating and thoroughly enjoyable.

RICHARD F. PETERS, Chief,
Bureau of Vector Control

Remember and look ahead to the dates January 24 through January 27. These are the dates of the AMCA and CMCA annual convention, to be held at Los Angeles, California.

The attractions of the Los Angeles area are probably as well known as any in the world, and here we have space to say only that the California Mosquito Control Association and the Los Angeles Chamber of Commerce working together on a convention can be relied upon to come up with something that will be a memorable experience —one that no one would want to miss.

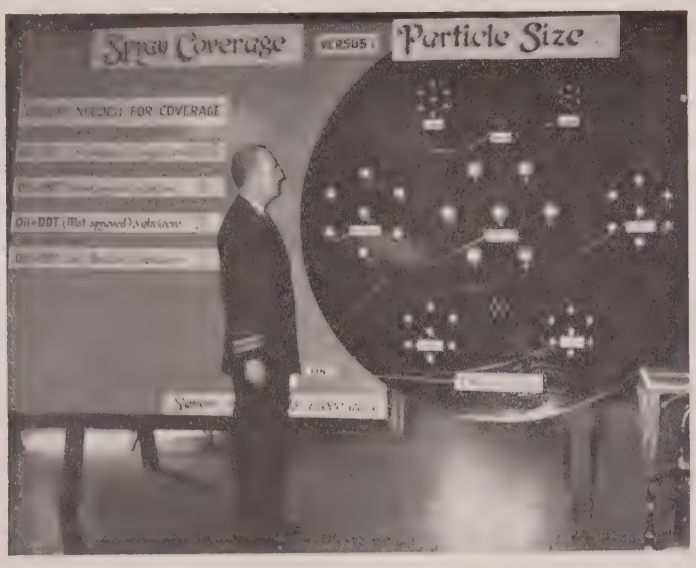
Information sent in by the Los Angeles Chamber of Commerce indicates that there are accommodations to suit every budget, and entertainment as well as instructive diversions for every member of the family. It is expected that specific details will be sent to AMCA members in time to allow adequate plans to be made.

In the meantime, start making those plans with the assurance that when the detailed program comes to you it will be just what you and as many members of your family as you can bring would like.

Erratum

In a recent article, *Mosquito News* 14:68–71, the undersigned discussed a species of mosquito that had been determined by Dr. Alan Stone. Through error the specific name was misspelled. The correct spelling as determined by Dr. Stone is *virgultus,* not *virgultis,* as published in the article. O. P. Breland

From Tommy Mulhern's camera at the Atlantic City meetings of the AMCA and N. J. M. E. A.



Commander Hirst and a very informative exhibit

L. to R.—Ted Raley, Rolly Dorer, Dr. F. C. Bishopp, and Fred Stutz, respectively, Executive Secretary, President, retiring President, and Vice President.

NEWS AND NOTES

FROM TAIWAN DON PLETSCH REPORTS in the Second Quarterly Report for 1954, issued 1 July, that his area was visited by Doctors Francisco Dy and Archie Hess, who reviewed conditions in Central Taiwan. Dr. Pletsch states that the decentralization of the malaria control program, undertaken concurrently with a considerable expansion, has met with a very enthusiastic and helpful response from *hsien* and township officials in almost all instances. Training of 141 supervisors, 652 foremen and 2,608 operators was accomplished in the northern and eastern regions and arrangements made for the local hire and training of two additional helpers per team (1304 men). Additional training in the southern district during July was planned to cover 223 foremen and 36 supervisors. Dr. Pletsch concludes that residual spraying of houses has virtually eliminated populations of *Anopheles minimus* and has materially reduced populations of *A. hyrcanus sinensis* for at least a 12-month period. In Taiwan, *A. minimus* is normally a house inhabiting anopheline and apparently is somewhat more susceptible to DDT than is *A. sinensis*. As a result, malaria has been notably reduced in all sprayed areas. Don and his family have returned for temporary duty in Washington, and Don plans to return to Taiwan late in September.

HELEN LOUISE TREMBLEY BECAME HELEN LOUISE DURKEE on June 18 in All Saints' Episcopal Church, Chevy Chase, Maryland, in a double ring ceremony. Her husband, Mr. Kenneth M. Durkee, television engineer, is taking charge of a new transmitter on Mt. Diablo, California, for KOVR. Mr. Durkee had previously been the assistant Chief Engineer of WMAL-TV in Washington, D. C. The couple left immediately for the San Francisco Bay area, where they expect to buy a home in Walnut Creek, near Oakland. Dinnie Jensen, AMCA member, attended as maid of honor and Dr. Herman Ellingson, of Naval Ordinance, gave the bride in marriage. Over 300 guests attended, although the wedding had been set ahead on short notice because of Mr. Durkee's unexpected change of location, and Helen Louise's house overflowed afterward in an informal but beautifully decorated reception for her many happy friends. Mr. and Mrs. Durkee may be temporarily addressed at 189 Marshall Drive, Walnut Creek, and expect to welcome AMCA members in their new home soon.

HELEN LOUISE DURKEE'S WEDDING somewhat overshadowed the news that on June 9th she had been the recipient of the George Washington University Alumni Award for meritorious achievement, an honor which merits a very respectful mention. It was given in recognition of her fine work on mosquitoes, done while she was with the National Institutes of Health in Bethesda, Maryland.

RUSSELL W. GIES, principal sanitary engineer for the Department of Health of Pennsylvania, was the recipient also of an honor of another but no less distinguished sort. Dr. Luis Vargas, Entomology Director of the Mexican National Institute of Health, informs us that he has named a new species of *Psychoda* fly after Mr. Gies. The newly-named insect, *Syntomoluba giesi* Vargas, was discovered in Merida, Yucatan and has been found to be a transmitter of Onchocerciasis, a disease which may lead to blindness. *Psychoda* flies are not, of course, ordinarily transmitters of disease and the new species is relatively rare but its importance in a semi-tropical region is obvious. It was apparently found in the neighborhood of the creeks and shallow streams in the hilly coffee-growing regions of the state. Mr. Gies, in expressing his pleasure at the courtesy, adds that he had the pleasure of visiting Dr. Vargas' excellent laboratories in Mexico City last February.

A. S. WEST, WHO IS NOW ACTING CHIEF OF THE ENTOMOLOGY BRANCH OF A. S. Division of Camp Detrick, at Frederick, Maryland, may be addressed at that position for the next 15 months. Inasmuch as Camp Detrick is so highly classified, it is highly unlikely that one will be able to *see* Dr. West, but it will be pleasant to have him once more in our midst, though invisible.

COMMANDER JOHN D. DECOURSEY, MSC, USN, is being transferred from the Naval Medical Field Research Laboratory, Marine Barracks, Camp Lejeune, N. C., to Naval Medical Research Unit No. 3, c/o American Embassy, Cairo, Egypt, where the Navy has long conducted some of its most interesting investigations.

COMMANDER KENNETH L. KNIGHT, MSC, USN, is now in the Division of Preventive Medicine of the Bureau of Medicine and Surgery, Washington 25, D. C. Dr. Knight replaces Dr. Holway as chief entomologist of that Division on a routine change of station.

COMMANDER RICHARD T. HOLWAY, MSC, USN, reaping the reward of faithful and efficient duty in the Washington endurance test on which Dr. Knight now enters, is now stationed at Pearl Harbor, Hawaii. His new address is the Preventive Medicine Unit No. 6, Navy No. 128, FPO, % Postmaster, San Francisco, Calif.

William E. Beckel, Writing from the Defence Research Northern Laboratory at Ft. Churchill, Manitoba, just slightly south of the Arctic Circle, sends in an interesting observation on the effects of aerial spraying. Although the data are not yet all collected, and Bill claims they are "not worth much," they seem to offer considerable food for thought and are summarized herewith. During the summers of 1952 and 1953, aerial spraying with DDT was carried out on a 10 square mile plot surrounding Ft. Churchill. Adult mosquitoes and blackflies were effectively controlled for 5 to 6 days, after which reinfestation occurred. However, unexpectedly, a considerable reduction was found in larval populations in the open pools of the tundra, and somewhat less so in forested areas.

After the second year of spraying, no larvae at all were recorded in the tundra pools inside the sprayed zone. During the past summer of 1954, a much more extensive area (25 square miles) has been sprayed and pools not previously treated have been included in the application. These were assessed for larval population prior to treatment and will be checked next summer for further confirmation of the effects of the spray.

Sam Minnich, Director of the East Volusia (Florida) Mosquito District, is reported by the Daytona Beach *Morning Journal* of 29 May to have made an interesting observation of another sort. Dredging in Thompson Creek, as part of his mosquito control drainage operations, Sam came up with a large bone which he claimed was the left anterior femur of a cow, though it would have had to be a sea cow in the location where it was found, but local archaeologists claimed it was a marine dinosaur. Anyway Sam got a front page center picture and story and reminded his constituents, in case the lack of mosquitoes had made them forget it, that mosquito control is a continuing operation.

Following His Return to Saigon, Harry H. Stage writes, "I have just returned from a month's study-visit to Japan with four Vietnamese colleagues. We travelled from Tokyo to Hiroshima and Nagasaki and saw many institutions and entomologists carrying on mosquito control and environmental sanitation. At Suogi, I visited the city officials who proudly showed me trophies won for their work against mosquitoes. In Kure [a large port city near Hiroshima—Ed.], I was presented with a ceremonial tea in an old temple and informed that over 6,000 Japanese officials and experts had visited the area to see their efforts on environmental sanitation but that I was the first American [since the Occupation—Ed.]. Never before have I seen such close cooperation between so many groups for the common purpose of destroying flies, mosquitoes, fleas, blackflies, rats and trash. When one of our party carelessly dropped a match to the ground, four heads bumped in an effort to retrieve it. The climax, however, was to find a pig pen screened to prevent fly breeding!

"The guiding light of all this effort is a Mrs. Osu, who is 72 years old and chairman of a group of 10,000 women whose interest is largely insect control and sanitation. Most of the work is done by women volunteers with materials and equipment furnished by businessmen and civic societies. Each child has a fly swatter and the children play games while walking to school, vying with each other to kill the most flies. As for myself, I saw none.

"I met Professor Omori, a member of the American Mosquito Control Association, at Nagasaki University. Of all the many observations made during my 40 years' experience in the study of mosquitoes, Dr. Omori showed me the most interesting. It was the breeding habitat of *Aedes nobukonis*, probably the rarest mosquito in the world. It is known to occur only in a dry and deep bamboo-filled ravine several hundred feet long and a few dozen feet wide, which in feudal days served as a moat around the castle. Today the moat is dry except during the rainy season and *Ae. nobukonis* breeds only in the rain pools of this very restricted area. In the world of natural science this is surely one of the rarest phenomena."

From Illinois, Franklin C. Wray sends in information on the defeat of a mosquito abatement detachment bill which would have established precedents of importance to mosquito control districts everywhere. He writes, "An effort was made during 1953 to pass a bill in the Illinois Legislature which would have permitted the owner or owners of one or more tracts of land lying within the corporate limits of an abatement district and located on the border of said district to have their land detached from the district.

"This bill, if passed, would have provided a means for opponents of mosquito control to withdraw from the district, thereby permitting owners of land thus placed newly on the district border to follow the same procedure. If such a chain reaction of withdrawals continued it could ultimately result in the dissolution of the district.

"Fortunately the bill died in the house in the closing days of the last session as a result of opposition from the State Department of Public Health. Although the attempt failed, this does not prevent another effort at the next session of the Illinois Legislature, or similar efforts may be made in other states."

While Mosquito Abatement is Under Fire in Some Quarters it is Receiving new impetus in other areas. On March 25th, 1954, Her Majesty Elizabeth II assented to the establishment of a Greater Winnipeg Mosquito Abatement District, which continues and expands the work which has been carried on for 27 years by the Greater Winnipeg Anti-Mosquito Campaign. Evi-

dence of the degree of local interest in the progress and success of this campaign showed in many news items and general interest stories appearing during the summer in the Winnipeg papers. On June 19, the *Winnipeg Tribune* carried a front page picture and story on the research into the possibility of polio transmission by mosquitoes, which is being carried on by the University of Manitoba, under Dr. J. A. McLeod and J. R. G. Sutherland. Another typical item was one which appeared on July 15 in the *Winnipeg Free Press*, which discussed the Abatement District's operations on the Red River, concluded that every mosquito downed was a "drop of blood saved for the Red Cross."

ANOTHER INSECT VECTOR AND PEST CONTROL TRAINING CONFERENCE was held by the Thirteenth Naval District during 16 to 18 August, in Seattle, Wash. More than 100 conferees were reported to have participated, including both civilian and military personnel of the District.

LT. COMMANDER JOHN M. HIRST, MSC, USN, is also responsible for sending us, in his informative newsletter from the Alameda Naval Air Station, the statement made by Forbes when Entomology was only a little over half its present 100 official years. Said Forbes, "We have never yet exterminated—we probably never shall exterminate—so much as a single species of insect." Dr. Hirst then appends a little jingle for the use of and amusement of mosquito exterminators:

> BIOLOGISTS are people who
> Observe what ants and cutworms do,
> And how a cotton weevil looks,
> And put what they have seen in books.
>
> But do they ever stop the ants
> That undermine the garden plants
> So that they drop their leaves and rot?
> No, gentle reader, they do not.

(To which the host of AMCA members might reply:

> It may be all too sadly true
> That we can't help what some bugs do
> But may we note, we hope sedately,
> MOSQUITOES HAVE ABATED, LATELY?)

THE SKEETER, OFFICIAL ORGAN OF THE VIRGINIA MOSQUITO CONTROL ASSOCIATION, among its many items of information and interest reports that the May-June issue of the National Agricultural Chemicals Association News contains a chart which shows that while high-powered insecticides, so often viewed with alarm, were responsible in 1949 for 15 deaths, aspirin and salycilates were responsible for 99. This makes aspirin a good deal more of a public menace than insect control agents, if the viewers with alarm want something to view with alarm. The same publication, *Skeeter*, notes from the Richmond *News-Leader* that while white men "learned only in comparatively recent times that malaria is carried by mosquitoes, the Masai, a tribe in Central Africa have known it for so long that their word for malaria means literally, 'I have been bitten by a mosquito.'" In this connection, a medal dug up from pre-Christian Rome is inscribed to the honor of a man who is described as saving the city from illness by draining marshes, the reverse of the medal showing a man in a marsh with a large, unmistakeable mosquito. Which seems to indicate again that in our sophistication we have forgotten things which we once knew.

IN JULY, THE CALIFORNIA VECTOR VIEWS made its initial appearance, under the aegis of the Bureau of Vector Control of the California State Department of Public Health and the editorship of Arthur C. Smith. This monthly bulletin contains articles of major importance in each issue, together with shorter articles of general interest, and notes on various phases of vector control. Material covers flies, mosquitoes, ticks, fleas, domestic and field rodents, insecticides, herbicides, government regulations, refuse disposal, irrigation and water management problems, as well as a host of related matters. Of especial interest to mosquito control workers is an article in the August issue on Chlorthion, one of the newer materials which has lately received intensive testing by both State and Federal agencies. *Vector Views* concludes that, "while it is premature to make any definite recommendations on its use, it is apparent that chlorthion at low dosages is effective against a wide spectrum of vectors and economic pests. Extremely encouraging results have been obtained in using this material as a residual spray for house flies resistant to hydrocarbon insecticides. Equally interesting have been the results obtained in applying chlorthion as a mosquito larvicide."

CALIFORNIA NOW HAS 41 ACTIVE MOSQUITO ABATEMENT DISTRICTS, according to the same August issue of *Vector Views*. These cover 23,936 square miles. "In addition," the *Views* goes on to say, "Mosquito control is conducted by eight local health departments in 790 square miles of area and by two pest abatement districts in 20 square miles. This gives a total coverage of 24,746 of California's 158,693 square miles. The major part of this total coverage occurs in the Central Valley."

ON 15 NOVEMBER, THE WESTERN PACIFIC AND SOUTH-EAST ASIA INTER-REGIONAL MALARIA Conference opens in Taiwan. Sponsored by WHO and meeting at the invitation of the overnment of China, the conference will spend 8 days in technical discussions of malaria control problems and field visits. The tentative schedule includes a trip to Southern Taiwan to visit a DDT manufacturing plant in Kao-Hsieng and the Taiwan Provincial Malaria Research Institute in Ch'ao-Chow.

IN A LETTER CONCERNING THE SPRAYING OF MONROVIA, LIBERIA, GEORGE BURTON writes that

the first operation was completed in March and the spraying was then transferred to the bush areas until the rains flooded the roads. Dr. Burton says that there seem to be many factors involved in the persistence of dieldrin and that there were indications that the spray began to be ineffective after about nine months in some cases. He remarks that one of the complications is the habit of the people of beating the house walls when they get up in the morning. Although the mosquitoes probably go up into the roof instead of out the windows, the habit may cause the dissemination of dust particles carrying dieldrin, which may be the cause of difficulties in keeping check rearings alive. George also notes that it is seldom possible to find parasites in a blood smear when the slide has been taken after the patient has had a severe chill, whereas after a fever the parasites are numerous. He says one of the hard things to adjust one's mind to is finding slides positive for malaria when one has taken them from "a bunch of gay, happy, exuberant children" whose appearance is anything but malaria-ridden. In another letter he writes: "We haven't had a single case of illness due to this insecticide [dieldrin]. In some cases exposures have been greater, due to a shortage of gloves and respirators, but still no ill effects among the men spraying. They have not used the goggles we have issued them, as they claim their eyes have not bothered them and the spray does not irritate their eyes in any way. We have used 0.3, 0.5 and 0.626 percent dieldrin suspension and emulsion. We are not relaxing our requirements, however, and insist that those who have protective clothing, respirators and gloves use them."

According to the California State Department of Public Health's Bulletin, "California's Health," the encephalitis surveillance program was continued energetically in 1954. While the number of hospital admissions has been low, and none of the blood specimens has been confirmed as either St. Louis or Western equine encephalitis, all cases showing central nervous system symptoms with fever have been reviewed and sampled. In the mosquito collection studies, 56 virus isolations have been made from 83 pools of *Culex tarsalis*.

In Massachusetts, during the current season, the second Greenhead-fly Control District, initiated to reduce the salt marsh tabanid population, went into operation along the north shore of Massachusetts Bay. The first and original district was organized along the south shore of Massachusetts Bay immediately upon completion of the greenhead-fly experimental control investigation of 1948. This new district was sponsored by a local federation of betterment associations known as the North Shore Associates. Approximately one-third of the cost of operation was borne by the State, and the remaining two-thirds by the municipalities forming the district. An additional contribution was received from the U. S. Fish and Wildlife Service to meet the expense incurred by the district in treating certain salt marsh areas included in the Parker River Refuge, a portion of which falls within the boundaries of the new district.—B. I. Gerry.

The Mosquito *Culiseta inornata* Williston previously unrecorded from Churchill, Manitoba, has been found in this region in large numbers in the larval stage. On August 7, 1953, approximately 900, second, third, and fourth instar *C. inornata* larvae were removed from a pool, previously described (Beckel and Barlow, 1953), in which *Aedes communis* (De Geer) larvae are found. The organisms were reared according to the method used for *Aedes communis* (Beckel and Copps, 1953) (Beckel, 1953). Initially, the females were offered blood in gauze bags soaked in a solution of blood and sugar (McLintock, 1952); this they fed on readily. After the first complete generation, blood was offered by suspending guinea pigs with shaved backs from the ceiling of the cage; blood was taken avidly. The colony was maintained for eight generations with little difficulty.

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The following letter is self-explanatory. It was forwarded to the editor by Secretary Ted Raley. It is printed herewith to bring it to the attention of persons who might qualify, and who might be interested. No mention was made of a deadline for the applications. The "brief description of duties" to which reference is made is on file in

the office of the Editor of Mosquito News and is available on request.—D. L. C.

4 July 1954

American Mosquito Control Association
1941 Front Street
Selma, California

Gentlemen:

The overseas command in Japan has forwarded to this office a personnel request for an Entomologist (Medical), GS-11, $5940 per annum. The minimum tour of duty in Japan is twenty-four (24) months.

Inclosed herewith is a brief description of the duties and responsibilities and a statement of requirements for the position.

If there is anyone you would care to recommend, please have such individuals write directly to the following address:

The Surgeon General
Department of the Army
Washington 25, D. C.
ATTENTION: MEDCM-CP

Sincerely yours,
(Sgd) E. W. LaCross
Personnel Division

APPLICATIONS FOR MANAGER WANTED

The Board of Trustees of the Alameda County Mosquito Abatement District announces the prospective retirement of its present Engineer-Manager between December 31, 1954 and March 31, 1955. The Board will receive applications for appointment as Manager of the District during the period October 1–30, 1954. Previous experience in the management of extensive mosquito control operations will be given primary consideration. Salary Schedule No. 40 ($611–645–681–719–760 per month) in five steps.

For an application form interested persons should write to the

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The Program of a Seminar Entitled

"THE USE OF FOGS AND MISTS FOR ADULT MOSQUITO CONTROL"

Presented by

THE AMERICAN MOSQUITO CONTROL ASSOCIATION

Sponsored by

THE NORTH-CENTRAL REGION—OTTO McFEELY, DIRECTOR

Host—The Toledo Area Sanitary District—P. B. Brockway, M.D., Director

HOTEL COMMODORE PERRY, TOLEDO, OHIO
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Registration—Third floor lobby.
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The Toledo Room — Third Floor

1 — Welcome addresses.
2 — Response by Rowland E. Dorer, President, AMCA.

PAPERS AND DISCUSSION

3 — "The Basic Principles of Mosquito Control".
4 — "Factors That Tend to Complicate The Practice of Mosquito Control".
5 — "How Ohio Is Combatting The Pollution Problem".
6 — "How Adult Mosquito Control Can Supplement The Basic Program".
7 — "Equipment Used to Control Adult Mosquitoes".
8 — "Insecticides Used in The Control of Adult Mosquitoes".
9 — "Evaluation of The Mosquito Control Program".

Second session—Thursday, September 30th, 9:00 A. M. to 12:00

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1 — "The Theory And Development of Fog Applicators".
2 — "Description of Fog Applicators Now In Use".
3 — "General Methods of Fog Application For Mosquito Control".
4 — "Operational Problems in The Community Use of Fog Applicators".
5 — "Safety Precautions in The Use of Fog Applicators".
6 — "The Use of Radio to Direct Fog Applications".
7 — "Maintenance and Repair of Fog Applicators".
8 — "The Cost of Fog Applications".

Third session—Thursday, September 30th, 2:00 to 5:00 P. M.

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2 — "Description of Mist-Dust Blowers Currently in Use".
3 — "General Methods of Mist Blower Operation".
4 — "Operational Problems in The Community Use of Mist Blowers".
5 — "Safety Precautions in The Use of Mist Blowers".
6 — "Maintenance and Repair of Mist Blowers".
7 — "Cost of Mist Blowing For Mosquito Control".
8 — "The Place of Fogs and Mists For Mosquito Control".

Some of the papers from this seminar will be published in the December and March numbers of *Mosquito News*

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